GUIDE

TO THE

CRUSTACEA, ARACHNIDA, ONYCHOPHORA AND MYRIOPODA

EXHIBITED IN

THE DEPARTMENT OF ZOOLOGY

BRITISH MUSEUM (NATURAL HISTORY),

CROMWELL ROAD, LONDON, S.W.

WITH 90 ILLUSTRATIONS.

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PREFACE

THIS Guide deals with the specimens which are exhibited in the Southern half of the "Insect Gallery." The great group Arthropoda, or animals with jointed legs and (usually) a hard exoskeleton, are here considered, with the exception of the Insects, which are described in a separate Guide. The present work is thus concerned with the Crustacea, mainly aquatic in habit, and represented by familiar animals such as Shrimps, Lobsters and Crabs; with the Arachnida, the Scorpions, Spiders, Ticks and their allies; with the Onychophora, constituted by the singular animal known as Peripatus; and with the so-called Myriopoda, including the Millipedes and Centipedes.

The section on the Crustacea is written by Dr. W. T. Calman, that on the Arachnida and Myriopoda by Mr. A. S. Hirst, and the portions dealing respectively with the Onychophora and with the Pentastomida (the latter regarded as degenerate Arachnida) by Mr. F. Jeffrey Bell.

Mr. R. I. Pocock, who was formerly in charge of the Arachnida and Myriopoda, and whose responsibility then included the arrangement of many of the specimens now exhibited, has been kind enough to read the proof-sheets dealing with those groups.

The thanks of the Museum are due to Messrs A. and C. Black for their permission to use certain blocks from Part vii (Dr. Calman's volume on Crustacea) of the "Treatise on Zoology," edited by Sir Ray Lankester, K.C.B., F.R.S., who has also given his sanction to their use in this Guide-Book. Figs. 10, 11, 13, 15, 18–22, 26, 27, 30 are derived from this source.

SIDNEY F. HARMER,

Keeper of Zoology.

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CROMWELL ROAD, LONDON, S.W.

February, 1910.

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CRUSTACEA, ARACHNIDA, ONYCHOPHORA AND MYRIOPODA.

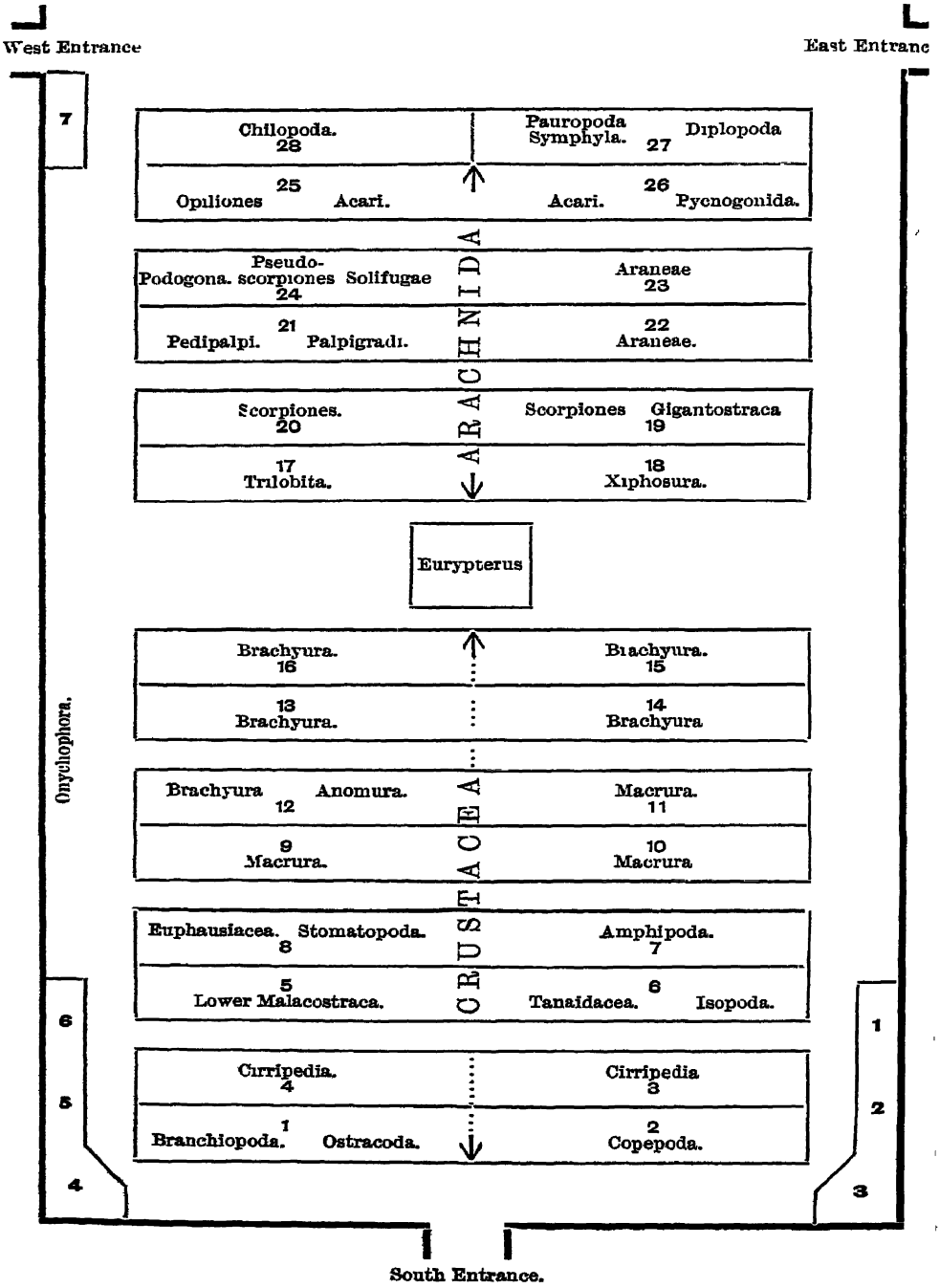
THE specimens exhibited in the "Insect" gallery belong to the comprehensive group ARTHROPODA, of which the animals usually known as Insects form only one of the divisions.

The Arthropoda may be defined as animals in which the body is more or less distinctly segmented, generally with a firm external skeleton, and with jointed limbs, some of which are modified to serve as jaws.

The group is divided, according to the system of classification followed in arranging the gallery, into six Classes :—

Class 1.—Crustacea (Crabs, Lobsters, etc).
,, 2.—Trilobita.
,, 3.—Arachnida (Spiders, Scorpions, etc., with Appendix, Pentastomida).
,, 4.—Onychophora (Peripatus).
,, 5.—Diplopoda (Millipedes). } MYRIOPODA.
,, 6.—Pauropoda. }
,, 7.—Symphyla. }
,, 8.—Chilopoda (Centipedes). }
,, 9.—Insecta (Moths, Flies, Beetles, etc.).

The Insecta are arranged in the northern half of the Gallery, and are described in a separate Guide. The remaining classes occupy the southern half of the Gallery, and are dealt with here in the order given above.



PLAN OF SOUTH HALF OF "INSECT GALLERY," SHOWING POSITION OF CASES OCCUPIED BY GROUPS DEALT WITH IN THIS GUIDE.

Class 1.—CRUSTACEA.

INTRODUCTORY.

The exhibited series of Crustacea occupies the southern part of the "Insect Gallery." The Table-cases Nos. 1–16 contain a series of typical representatives of the various Sub-classes and Orders composing the Class, arranged in systematic order. The Wall-Cases Nos. 1–6 contain exhibits illustrating the structure and life-history of the Lobster, and forming an introduction to the study of the Crustacea; a number of specimens illustrating the habits and mode of life of various Crustacea; and sundry specimens which, by reason of their size, could not conveniently be exhibited in their proper places in the systematic series.

DEFINITION OF CRUSTACEA.

The Class Crustacea, as understood by modern zoologists, comprises the forms commonly known as Crabs, Lobsters, Crayfish, Prawns, Shrimps, Sandhoppers, Woodlice, Barnacles, and Water-Fleas, besides a multitude of related forms undistinguished by any popular names. It does not include the King-Crabs (Xiphosura) and Sea-Spiders (Pycnogonida), formerly associated with it, but now regarded as more closely related to the Arachnida.

The Crustacea differ so widely among themselves that it is very difficult to give a definition of the group which will apply to all its members, and it is hardly possible to do so without entering into highly technical details of structure and development which would be out of place here.

It may be said, however, that they differ from Insects, Arachnida, and the other groups which, together with Crustacea, form the comprehensive group (Phylum or Sub-Phylum) Arthropoda, in having two pairs of antennae (feelers) in front of the

mouth and at least three pairs of jaw-like appendages behind the mouth, in being nearly always of aquatic habits, and in breathing by gills or by the general surface of the body.

A Crustacean can usually be distinguished from any other Arthropod by the fact that its "walking-legs" do not correspond in number or arrangement with those found in the other groups Thus an Insect can usually be recognised at first sight by having three pairs of legs, an Arachnid by having four pairs, and a Centipede or a Millipede by having a great number of legs, all nearly alike. The Crustacea, on the other hand, show a great variety in the arrangement of their walking or swimming legs, but they very seldom exhibit any special resemblance, in respect of these appendages, to the other large groups of Arthropods.

THE LOBSTER AS A TYPE OF CRUSTACEA.

Wall-cases Nos. 1–3.

The plan of structure common to the whole Class will be best understood by beginning with the study of a typical form.

For this purpose the common Lobster has been selected as being easily accessible, of convenient size, and not too specialised to admit of ready comparison with other Crustacea.

The Crayfish, which is the type more usually described in text-books, differs only in minor details from the Lobster.

Like the other Arthropoda, the Crustacea have the body and limbs encased by a firm covering which gives support to the soft internal organs and in particular affords points of attachment for the muscles by means of which the animal moves. In other words, this covering plays the part of a skeleton; but since, unlike the bony skeleton of Vertebrate animals, it is outside instead of inside the soft parts, it is distinguished as an "exoskeleton." In many Crustacea also, the exoskeleton is sufficiently strong to serve the purpose of defensive armour, and to enable the limbs to act as efficient and powerful weapons.

Although the firm outer covering is really continuous over the whole of the surface of the body and limbs, it becomes thinned away in places to form joints permitting movement between the various parts. Thus, the body and limbs are divided into "segments" *

* The word "joint," often applied to these divisions of the body and limbs, ought properly to be restricted to the hinge or connection between two segments.

which, in the case of the body, are termed body-segments or "somites."

A study of the various modifications of structure presented by Crustacea and other Arthropoda has led to the conclusion that they are to be regarded as built up of a series of somites or body-segments, which may be distinct or soldered together, and each of which bears typically a single pair of limbs or appendages. Wall-cases Nos. 1–3.

Thus, in the Lobster (Fig. 1), the hinder half of the body (or abdomen) is plainly made up of six somites (besides a tail-piece or

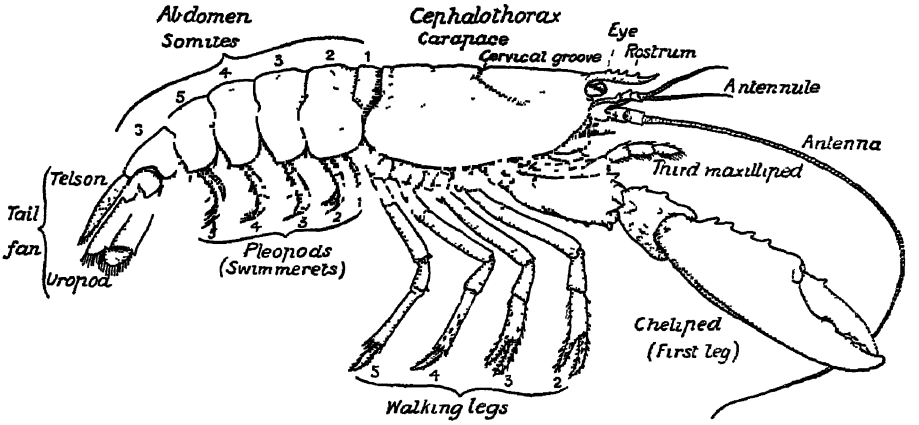


FIG 1

The Common Lobster (*Homarus gammarus*). Female, from the side [Wall-case No 1.]

"telson"), each of which carries on the under side a pair of "swimmerets." The front half of the body is not so divided, but is covered by a large shield or "carapace" which projects between the eyes as a toothed beak or "rostrum" Since, however, this part of the body also bears a number of appendages constructed on the same plan as the swimmerets of the abdomen, it is concluded that here also we have to do with a series of somites, although they are so completely fused together as to be indistinguishable except by their appendages. That this conclusion is correct is proved by comparison with some of the lower Crustacea, for instance, *Anaspides* (see Table-case No. 5), in which there is no

Wall-cases Nos. 1–3.

carapace, and the fore part of the body has eight distinct somites each bearing a pair of walking legs. In front of these eight somites, which form what is called the "thorax," is the "head," a part of the body which is never, in any Crustacean, distinctly segmented, but which, since it bears five pairs of appendages, must contain at least five somites. The part of the body covered by the carapace of the Lobster includes the head and the thorax and is known as the "cephalothorax." It is necessary to remark, however, that the regions of the body named head, thorax, and abdomen in the Crustacea are by no means exactly equivalent to those so named in the other Arthropoda, for instance in Insects, and still less to the parts bearing the same names among Vertebrate animals.

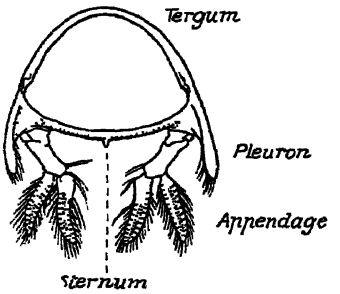


FIG. 2.

One of the abdominal somites of the lobster, with its appendages, separated and viewed from in front [Wall-case No. 1.]

This "segmentation" of the body, or division into somites, is not only shown by the external covering, but affects some of the internal organs as well. Leaving these aside for the present, however, and considering only the exoskeleton, the structure of a typical somite will be best understood by examining one of the separated abdominal somites of the Lobster (Fig. 2). This consists of a ring of shelly substance, connected with the rings in front and behind by areas of thin membrane which permit movement in a vertical plane. For convenience of description the upper or dorsal part of this ring is called the "tergum" (or "tergite") and the under or ventral part the "sternum" (or "sternite"). To the sternum are attached the appendages (or swimmerets), while the tergum overhangs the base of the appendage on each side as a flap called the "pleuron." The terminal segment of the body or "telson" never bears typical limbs, and on this account and also because of its mode of development in the embryo, it is not regarded as a true somite.

The carapace of the Lobster is not formed simply by the terga of several adjacent somites becoming soldered together. This is shown by a comparison with some of the lower shrimp-like Crustacea (Mysidacea, *see* Table-case No. 5), in which the carapace

is seen to arise, as a fold of the skin, from the hinder edge of the head-region, and to envelop the distinctly segmented thorax like a loose jacket. In the Lobster, this fold has coalesced, down the middle of the back, with the terga of the thoracic somites, but at the sides it hangs free, enclosing a "branchial cavity" in which the gills lie between it and the side of the body. The free part of the carapace which covers the branchial cavity is known as the "branchiostegite," and its front end is marked off on the outside of the carapace by an oblique "cervical groove" (Fig. 1), which has been supposed to indicate the limit between the head and the thorax. Wall-cases Nos. 1–3.

Appendages.—Excluding the movable stalks on which the eyes are set and of which the nature will be discussed later, the body of the Lobster carries nineteen pairs of appendages. In front of the head are two pairs of feelers, the "antennules" and "antennae" respectively (sometimes called the first and second antennae); near the mouth are three pairs of jaw-appendages, the strong "mandibles" and the flattened leaf-like "maxillulae" and "maxillae"; following these, which belong to the head-region, are three pairs of thoracic appendages, the "maxillipeds," which form a transition between the true jaws and the legs The large claws and the four pairs of walking legs may simply be termed "legs," and together with the three pairs of maxillipeds, correspond with the eight somites of the thorax already referred to. The six somites of the abdomen have each a pair of appendages, those of the first five being known as swimmerets ("pleopods"), while those of the last somite are known as the "uropods," and are large, flattened appendages spread out on each side of the telson to form the tail-fan. All these appendages can be shown to be constructed on a common plan, which is seen in a simple form in the case of the swimmerets. Each of these consists (Fig. 2) of a stalk, the "protopodite," with two branches known respectively as the "endopodite" (on the inner side) and the "exopodite" (on the outer side). The protopodite itself is composed of two segments; the first, very small, is the "coxa," and the second, much larger, is the "basis."

If the other limbs be compared with the swimmerets it will be found that they can be derived, without much difficulty, from the simple type. The *antennules* (Fig. 1), which appear most simple, are perhaps the least easy to interpret. Although they plainly consist, like the swimmerets, of a stalk and two branches, there are reasons for doubting whether these three parts correspond with

Wall-cases Nos. 1–8.

the protopodite, exopodite, and endopodite respectively. In the *antenna*, on the other hand, there is little difficulty in recognising the two segments of the protopodite, the exopodite reduced to a small movable plate or scale, and the endopodite drawn out into a long lash or flagellum of very numerous small segments.

The mouth-parts will be best understood by comparing them in order from behind forwards, beginning with the *third maxilliped* (Fig. 3). In this appendage it will be seen that the second segment of the protopodite carries an exopodite which ends in a lash or flagellum of numerous segments, and an endopodite of five segments which forms the main part of the limb. In addition to these divisions, however, there is another part not present in the swimmeret which we have taken as the type. This is the "epipodite," a membranous plate attached to the outer side of the first segment (coxa) of the protopodite, and bearing one of the gills (to be described later) attached to it. The *second maxilliped* is not dissimilar in structure, though much smaller than the third, but the *first maxilliped* differs considerably from both. The same parts can be recognised in it, but the endopodite is shorter than the exopodite and has only two segments; and the two segments of the protopodite grow out on their inner side into two large plates, fringed with bristles and serving as jaws. In the *maxilla* (*second maxilla*), these jaw-plates ("gnathobases") are still more developed and each is slit into two The endopodite is small and unsegmented, while on the outer side is a large plate which is probably the exopodite, although some have regarded it as the epipodite. Whatever its nature, this plate has an important function, since it lies in a channel leading forwards from the gill-chamber and serves by its continual movements to keep a current of water flowing over the gills. The *maxillula* (*first maxilla*) consists of little else than the two gnathobases, here undivided, and a small endopodite. The strong *mandibles* are clearly the chief instruments in the mastication of the food, to which the other mouth-parts are only accessory. Each consists of a massive "body" which seems to represent the first segment of the protopodite

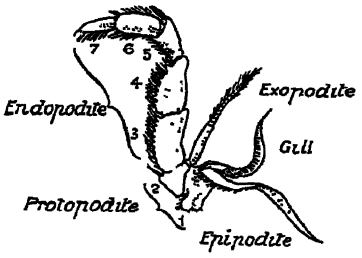


FIG. 3.

Third maxilliped of Lobster. [Wall-case No. 1.]

with its gnathobase, and a small "palp" of three segments representing the rest of the protopodite with the endopodite. Wall-cases Nos 1–3.

The rest of the appendages may be briefly disposed of. The *walking-legs* (Fig. 1) can easily be seen to correspond, segment for segment, with the third maxillipeds, except that they have no exopodites The large claws (*chelipeds*), like the two pairs of legs immediately succeeding them, are chelate or pincer-like. This modification, which is very frequent among Crustacea in limbs used for seizing food, is brought about by the penultimate segment of the limb growing out into a process, the "immovable finger," lying alongside the last segment, which can be brought into contact with it and is known as the "movable finger."

The movable *stalks*, upon which the eyes are set, are divided into two segments and in a few Crustacea they are even composed of three. The view was long and widely held that these stalks were the equivalent of a pair of appendages like the legs or jaws There are some reasons, however, for believing that this is not the case, and the eye-stalks are therefore omitted from the list of the Lobster's appendages given here.

Some of the gills (*branchiae*) of the Lobster are seen attached to the epipodites of the thoracic limbs. Their exact arrangement, however, is more clearly shown by the preparations in spirit exhibited alongside. In a transverse section through the thorax it is seen that the gill attached to the epipodite of the leg lies on the outer side of the branchial chamber. It is known as a "podobranchia." Next to it on the inner side are two gills which spring not from the leg itself, but from the membrane of the joint between the leg and the body. These are called "arthrobranchiae" Finally, next the inner wall of the chamber, is a gill attached to the wall of the body itself and known as a "pleurobranchia." The complete set of four gills is not present on every thoracic somite and the arrangement differs very much in different Crustacea.

Internal Anatomy.—The general arrangement of the internal organs of the Lobster is shown by a preparation in which the animal is dissected from the side (Fig. 4). The *alimentary canal* begins with a short gullet or "oesophagus" leading upwards from the mouth into the large "stomach," from which the "intestine" runs straight backwards to the vent on the under side of the telson. The stomach is not very suitably named, for it is probably not the place where the chief processes of digestion go on, but on the other hand it contains a complex apparatus known as the "gastric mill" which acts as a gizzard in grinding up the food.

Wall-cases Nos. 1–3.

It is divided into two chambers, a larger one in front, the "cardiac chamber," which serves as a kind of crop, and a smaller "pyloric chamber" behind. In the narrow opening between the two chambers are set three strong teeth which are connected with a system of plates and levers lying in the stomach-wall and moved by special muscles. This development of hard plates and teeth is associated with the fact that the whole stomach is lined by a membrane continuous at the mouth with that which covers the surface of the body and becomes thickened and hardened to form the shell. The external membrane also becomes turned in at the vent to line a considerable part of the intestine.

On each side of the thoracic region of the body is a large

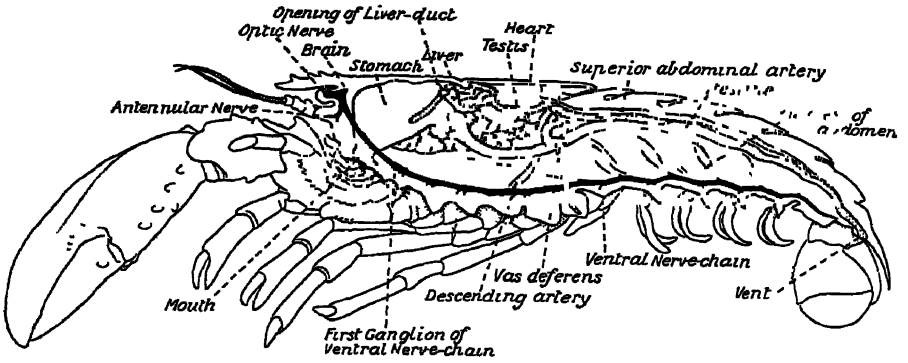


Fig 4.

Dissection of male Lobster, from the side [Wall-case No 1]

glandular mass, the "liver" or digestive gland, which opens into the alimentary canal by a short duct on each side just behind the stomach.

The *heart* lies near the back, just under the hinder part of the carapace. It gives off a number of large arteries in front and behind, as well as one ("descending artery") which runs downwards to the sternal surface of the thorax. As in other Arthropoda, there are no distinct veins, but the blood is discharged from the smaller arteries into the general cavity of the body and finds its way by ill-defined venous channels, first to the gills, and from these to the "pericardium" or space surrounding the heart. From the pericardium the blood returns through six valvular openings into the heart itself.

The *excretory system* (corresponding in function with the

kidneys of the Vertebrate animals) is represented by a pair of glands known as the "green glands" lying at the sides of the head and opening to the exterior each on a small tubercle on the first segment of the antenna. Wall-cases Nos. 1–3.

The *central nervous system* consists of a "brain," lying in front of the head, connected by a pair of cords which pass on either side of the gullet with the "ventral nerve chain" in which may be distinguished twelve nerve centres or ganglia.

The *eyes*, as already mentioned, are set on movable stalks. The black, kidney-shaped area at the end of the stalk can be seen, under a magnifying lens, to be divided into numerous minute facets (some 13,500 in number), for the most part square in outline. It is not correct to state, as is sometimes done, that each facet corresponds to a separate eye, forming a separate image of the object looked at; the whole assemblage of facets and the structures underlying them co-operate to form a single image on the receptive nerve-endings in the interior of the eye.

In the basal segment of the antennule is the so-called *auditory organ*, a small pouch open to the exterior and containing in its cavity a number of grains of sand. This pouch, which has on its inner surface numerous feathered hairs connected with a large nerve, was formerly regarded as the Lobster's ear. Although it is not impossible that it may have to do with the sense of hearing, recent investigations have shown that its principal function is connected with maintaining the equilibrium of the body in walking or swimming.

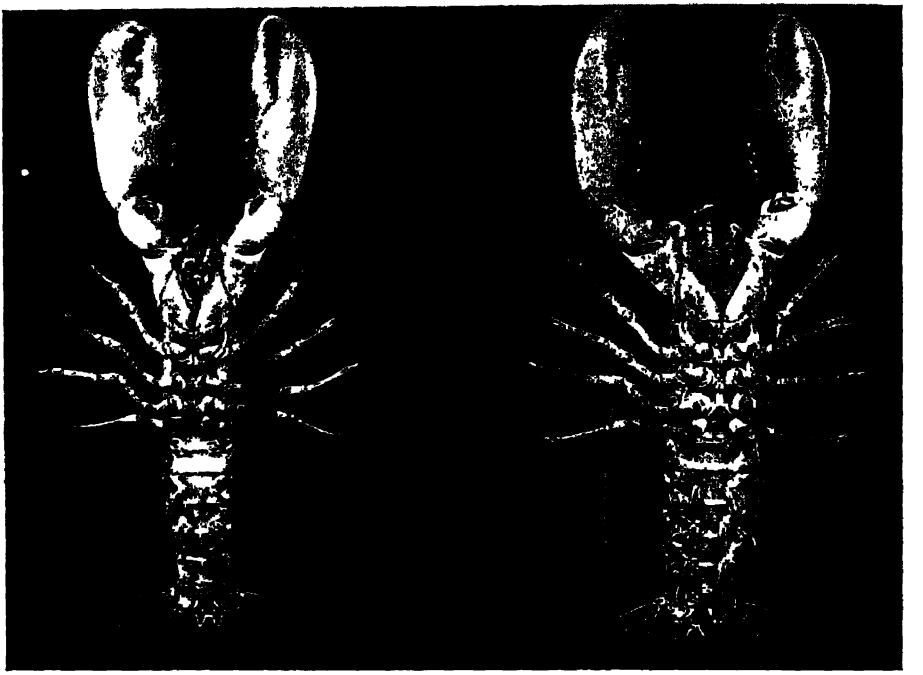
The dissection exhibited (see Fig. 4) is one of a male Lobster, and the *testis* can be seen lying below the heart and giving off a duct, the *vas deferens*, which opens to the exterior on the coxa of the last pair of legs.

Differences between the sexes.—Two preparations are exhibited in order to show the chief external differences between the sexes of the Lobster (Fig. 5). The most easily noticeable differences are the greater breadth of the abdomen and the larger size of its side-plates in the female than the male. The first pair of swimmerets (which, unlike the other pairs have only one branch in both sexes) are very slender in the female, but are much larger and peculiarly shaped in the male. The second pair have an additional lobe on the inner side of the endopodite in the male. The openings of the genital ducts can be seen on the first segment (coxa) of the last pair of walking legs in the male, and on that of the last pair but two in the female. Finally, the female has on

Wall-cases Nos. 1-3.

the under surface of the thorax, between the last two pairs of legs, a curious three-lobed structure with a slit-like opening in the middle, known as the "sperm-receptacle."

As in most Crustacea, the eggs are carried, after spawning, by the parent Lobster, and, as in most of the higher Crustacea (Decapoda), they are attached to the swimmerets on the under



Male. Female.

FIG. 5.

Male and Female Lobsters, showing the difference in the relative breadth of the abdomen in the two sexes. This figure also illustrates the dissimilarity of the large claws and the fact that the large "crushing-claw" may be on either the right or left side of the body [Wall-Case No. 1.]

surface of the abdomen. The female Lobster carrying spawn in this way is said by fishermen to be "in berry." A specimen in this condition is shown in spirit, and a drawing, in natural colours, is hung in the upper part of the Case. The number of eggs carried by a single Lobster may vary from about 3,000 to nearly 100,000.

Development.—Like most other Crustacea, the Lobster when hatched from the egg differs considerably in form from the

adult animal. An enlarged drawing of this stage is hung in Wall-case No. 2. The most important differences from the adult are the absence of all the abdominal appendages (pleopods and uropods) and the presence on each of the legs of an *exopodite*. These exopodites are fringed with hairs and are used as swimming organs, by means of which the larvae move rapidly about at the surface of the sea. At a later stage (see drawing), the exopodites of the legs are lost and the young animal, which has now assumed the essential structure of the adult, sinks to the sea-bottom. In many Crustacea the changes of form between the larval and the adult state are much greater than they are in the Lobster, but in some cases they are less marked, and the animal is hatched in what is practically the adult form. Wall-cases Nos. 1-3.

Moulting.—As already mentioned, the outer covering of the Lobster is quite continuous over the whole surface of the body and limbs. It consists of a substance known as "chitin," which resembles horn and is hardened by the deposition of lime-salts to form the shelly parts of the exoskeleton. At the joints the covering is thin and soft and contains no lime. As this covering will not stretch to any great extent, the Lobster, like all other Arthropoda, requires to cast its shell at intervals as it grows. In this process of *moulting* (or ecdysis) the integument of the back splits between the carapace and the first abdominal somite; and the body and limbs are gradually withdrawn through the opening, leaving the cast shell with all its appendages almost entire. The new shell, which had been formed underneath the old before moulting, is at first quite soft, and the animal rapidly increases in size by the absorption of water. The shell gradually becomes hardened by the deposition of lime-salts.

Several series of specimens illustrating the process of moulting are exhibited in Wall-case No. 3. These have been prepared and presented to the Museum by Mr. and Mrs. H. J. Waddington, of Bournemouth, who have been very successful in keeping marine animals alive for long periods in aquaria. Two cast shells, obtained successively from a single Lobster, and the Lobster itself preserved in the "soft" condition immediately after escaping from the second of these, show very clearly the increase in size at each moult, and the same point is illustrated in a different way by a drawing hung in this case, in which are superposed the outline of a Lobster before moulting and the outline of the same animal a few hours after the moult.

In a jar in the centre of the case are shown several specimens

Wall-cases Nos. 1–3.

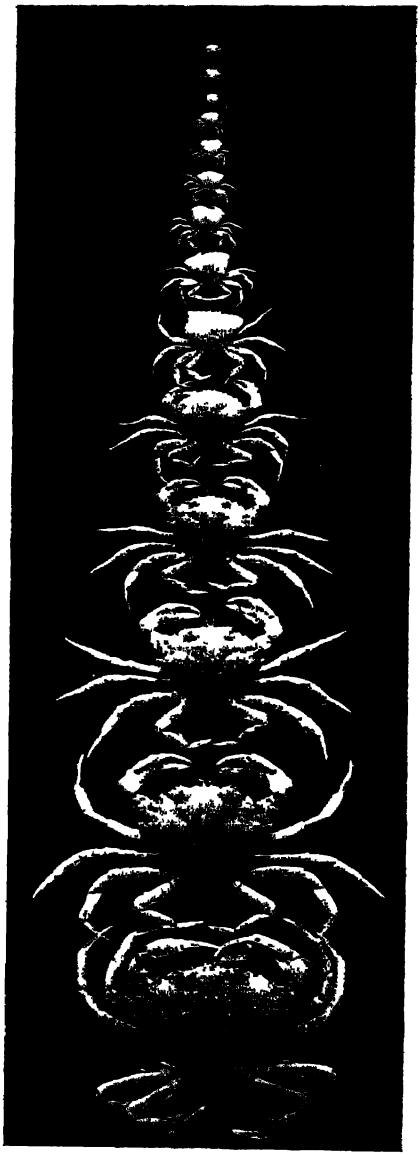


FIG. 6.

Series of cast shells obtained from a single individual of the Shore-Crab (*Carcinus maenas*) kept in an aquarium. The carapace of the largest is about 2½ inches wide. [Wall-Case No. 3.]

of the Edible Crab, of which one is in the act of moulting. The carapace has become separated from the abdomen and legs, and the body is beginning to be withdrawn from it.

On the right of the case is a series of cast shells obtained from a single individual of the Shore-Crab (Fig. 6). The crab was captured on 14th May, 1901. It was then in the second larval or Megalopa stage, and was found swimming at the surface of the sea. It lived in Mr. Waddington's aquarium till 20th July, 1904, and during that period it moulted seventeen times. All the cast shells, except two which were destroyed by accident, are exhibited.

In the lower part of the case two very beautiful series are exhibited, each obtained from a single Lobster in Mr. Waddington's aquaria, and together they give an almost complete picture of the growth of the animal from an early post-larval stage until it reaches a marketable size. The younger series begins with a specimen of about ⅛ths inch length of body, which moulted on 21st August, 1906; the latest of the fourteen moults exhibited was obtained on 8th June, 1909, when the animal was about 4⅛ inches in length. The second series begins with a specimen

of about 4½ inches long, obtained on 16th September, 1904. Between that date and 31st July, 1909, when the lobster died, it moulted seven times and grew to a length of 9 inches. Wall-cases Nos. 1–3.

Asymmetry.—A point on which information is often asked, the unlikeness in size and shape of the great claws of the Lobster and other Crustacea, is illustrated by specimens in Wall-case No. 1. In the preparations of the male and female Lobster (Fig. 5), for instance, or in the pair of claws from a very large Lobster in the lower part of the case, it will be seen that one of the claws is more massive than the other and that the fingers are armed with blunt knobs. It is, in fact, used for crushing the shells of animals on which the Lobster may be feeding, and is known as the "crushing-claw." The other is more lightly built, with sharp saw-like edges to the fingers, and is known as the "cutting-claw." There is no rule as to the side of the body on which either form of claw is found, "right-handed" and "left-handed" specimens being about equally common. In others of the higher Crustacea the disparity in size of the two claws is much greater than in the case of the Lobster. This is shown by the claws of the large Tasmanian Crab (*Pseudocarcinus gigas*), of which a pair is exhibited in the lower part of Wall-case No. 1, and other examples will be found in the table-cases. In some crabs the larger claw is more or less constantly on the same side of the body; that is to say, right-handed (or, more rarely, left-handed) individuals predominate.

Occasionally, in the Lobster, specimens with similar claws occur. Most commonly, in these, both claws are of the cutting type, but, very rarely, specimens like that shown in the lower part of Wall-case No. 1, are found in which both claws are of the crushing type. The mode of production of such abnormalities is not fully understood, but it seems probable that in most cases it is associated with the regeneration of limbs removed by accident or thrown off after injury.

MODIFICATIONS CAUSED BY PARASITES.

A series of specimens, exhibited in Wall-case No. 2, illustrate the changes of structure produced in certain crabs which are infested by the degenerate Crustacean parasite *Sacculina*. It is a curious and significant fact that these changes affect almost exclusively

Wall-cases Nos. 1–3.

the secondary sexual characters of the crabs. The details of the modifications are explained at length in the labels accompanying the specimens, and need not be recapitulated here; but it may be said in general that the characters distinctive of either sex, *e.g.*, the large chelipeds of the male, or the egg-carrying appendages of the abdomen in the female, become reduced in infected specimens, and that in some cases the male may even assume the characters of the female, although it would appear that females never take on distinctively male characters.

ADAPTATION TO ENVIRONMENT.

Wall-cases Nos. 1–6.

The remaining specimens in Wall-cases 1–6 will, for the most part, be referred to in describing the systematic series to which they properly belong. A number of exhibits, however, attempt to reconstruct the natural environment of the animals, and may conveniently be mentioned here. It is, of course, very hazardous to attempt to apply theories of "protective resemblance" to explain the characters of animals that are preyed upon by, and in turn prey upon, organisms, of which the sense-organs differ widely from our own; but it is at all events certain that—to human eyes—the slender thread-like Caprellids are extremely hard to detect among the branches of the Hydroid zoophytes to which they cling (Wall-case No. 4), and that it is very difficult to sort out the little pebble-like *Ebalia* (Wall-case No. 6) from the gravel brought up by the dredge. Still more effective are the disguises assumed by certain crabs of the tribe Oxyrhyncha, and illustrated by the specimens of *Macropodia*, *Maia*, and *Hyas* in Wall-case No. 6. In these crabs the surface of the body and limbs is covered by a mass of living seaweeds, sponges, and zoophytes, which render the animals almost invisible when they crouch motionless at the bottom of a rock-pool. It has been found that when this covering is removed artificially, or when after moulting the surface of the body is clean, the crab actually plants little fragments of seaweed and the like on its own back. The fragments are held in place by hooked hairs on the surface of the body, and they continue to grow and thrive in their new position.

SYSTEMATIC SERIES.

Table-cases Nos. 1–16.

The following table gives the system of classification which has been adopted in arranging the collection —

Class *CRUSTACEA*.

Sub-class BRANCHIOPODA . . .	Order	Phyllopoda.
	,,	Cladocera.
,, OSTRACODA	,,	Myodocopa.
	,,	Podocopa.
,, COPEPODA	,,	Eucopepoda.
	,,	Branchiura.
,, CIRRIPEDIA	,,	Thoracica
	,,	Acrothoracica.
	,,	Ascothoracica.
	,,	Apoda.
	,,	Rhizocephala.
,, MALACOSTRACA.		
Series LEPTOSTRACA.		
Division *Phyllocarida* .	Order	Nebaliacea
Series EUMALACOSTRACA.		
Division *Syncarida* . .	Order	Anaspidacea.
,, *Peracarida* .	,,	Mysidacea
	,,	Cumacea.
	,,	Tanaidacea.
	,,	Isopoda.
	,,	Amphipoda
,, *Hoplocarida* .	,,	Stomatopoda
,, *Eucarida* .	,,	Euphausiacea
	,,	Decapoda.

Sub-class I.—BRANCHIOPODA.

Table-case No. 1

This Sub-class includes a number of very primitive Crustacea which differ widely from one another in many points of structure, but agree in having the appendages of the trunk, for the most part, flattened and leaf-like It is divided into two Orders, *Phyllopoda* and *Cladocera*.

Order 1.—Phyllopoda.

The number of somites is large (about 14 to 40) and the trunk-appendages may be still more numerous (up to 60), several pairs being sometimes borne on each somite in the posterior region of the body.

The Phyllopoda are specially interesting on account of their

Table-case No. 1.

primitive characters. In the large number of the somites and the uniformity of the limbs, as well as in some points of internal structure (heart, nervous system) they approach more closely than any other living Crustacea to the hypothetical ancestral type of the Class. In some respects, however, such as the reduction of the mouth-parts, they are considerably specialized.

The order includes three Sub-orders (sometimes ranked as Orders) the members of which differ widely in external appearance. They are found in fresh water or in brine pools.

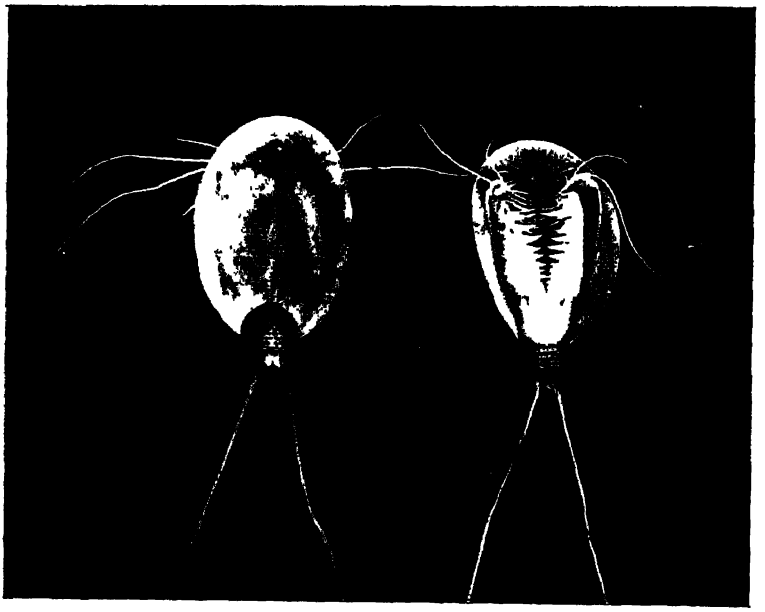


FIG. 7.

Apus cancriformis, from Kirkcudbrightshire, slightly enlarged. [Table-case No. 1.]

In the Sub-order ANOSTRACA there is no carapace and the animals have a more worm-like appearance than is usual in Crustacea. The eyes are set on movable stalks. The males are distinguished by the remarkable development of the antennae, which form complicated clasping organs for seizing the females. This is well shown in the specimen of *Streptocephalus rubricaudatus* exhibited.

In the Sub-order NOTOSTRACA the carapace forms a broad dorsal shield, resembling, at first sight, that of the Arachnidan King-crabs. *Apus cancriformis* (Fig. 7) is found in fresh-water

pools and ditches in many parts of Europe, but it is very uncertain in its occurrence, and it may suddenly reappear in numbers after an absence of many years. Males are rarely found. It was formerly found in several localities in the South of England, but no British specimens were seen for upwards of forty years, and the species was supposed to be extinct in this country. In 1907, however, it was discovered by Mr. F. Balfour Browne, in Kirkcudbrightshire, and some specimens obtained by him are exhibited. The eggs of *Apus*, and indeed of most Branchiopoda, can survive being dried, and they may be carried from place to place in mud adhering to the feet of wading birds or in other ways. There can be little doubt that the recent appearance of the species in Scotland was due to introduction of the eggs in some such way from the Continent. Table-case No. 1.

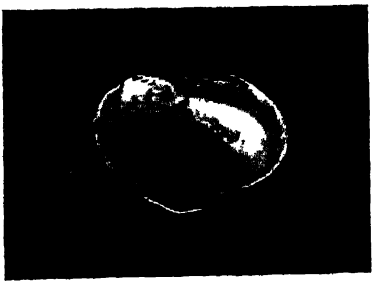


FIG. 8.

Estheria melitensis (slightly enlarged). [Table-case No 1.]

The species of the Sub-order CONCHOSTRACA have the body enclosed in a bivalved shell, which resembles very closely the shells of some Molluscs. The genus *Estheria* (Fig. 8), of which specimens are exhibited, is of interest on account of its geological antiquity; fossils referred to the genus occur in rocks of the Devonian period.

Order 2.—Cladocera.

The number of somites is small. There are from four to six pairs of trunk-limbs. The carapace generally forms a bivalve shell, enclosing the body and limbs but leaving the head free. The antennae are large and two-branched, and are used in swimming.

The Cladocera are generally very small animals, and from their jerky mode of swimming have received the name of "Water-fleas." They are abundant everywhere in ponds and ditches, and a few species are found in the sea.

One of the commonest species in fresh water is *Daphnia pulex*, of which specimens are exhibited together with an enlarged drawing of the animal as seen under a low power of the microscope

Table-case No. 1.

(Fig 9). *Leptodora kindtii* is the largest species of the Order. It is found chiefly in lakes, and its glassy transparency makes it a very beautiful object when alive. It is exceptional in the small size of the carapace, which does not enclose the body and serves only as a brood-pouch.

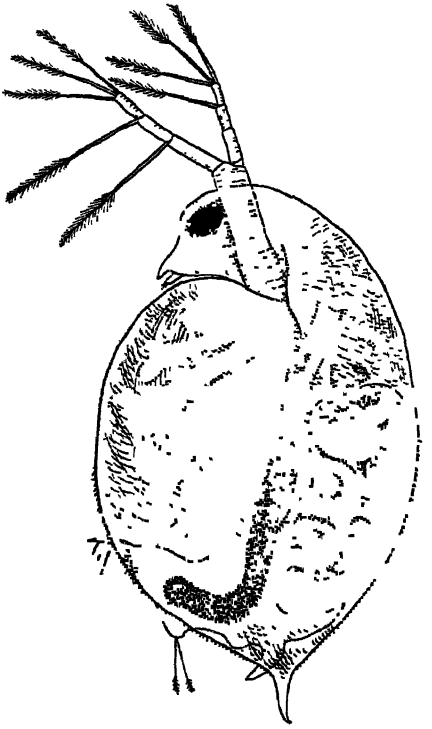


FIG. 9.

Daphnia pulex. Female carrying eggs in the brood-chamber. Enlarged [Table-case No. 1.]

Sub-class II.—OSTRACODA.

The number of somites, as indicated by the appendages, is smaller than in any other Crustacea, there being, at most, only two pairs of trunk-limbs behind those belonging to the head-region. The carapace forms a bivalved shell completely enclosing the body and limbs. There is a large, and often leg-like, palp on the mandible. The antennules and antennae are used for creeping or swimming.

The Ostracoda (Fig. 10) are for the most part extremely minute animals, and only one or two of the larger species can be exhibited. They occur abundantly in fresh water and in the sea, and their fossil remains are found in all geological formations from the oldest to the most recent. Nearly all the Ostracoda belong to two Orders, the *Myodocopa* and the *Podocopa*, of which the former may generally be distinguished by a notch (Fig. 10, *n*) in the anterior part of the margin of the shell which is absent in the latter. Table-case No. 1.

A series of enlarged drawings gives some idea of the diversity of form and ornamentation in the shells of these minute Crustacea.

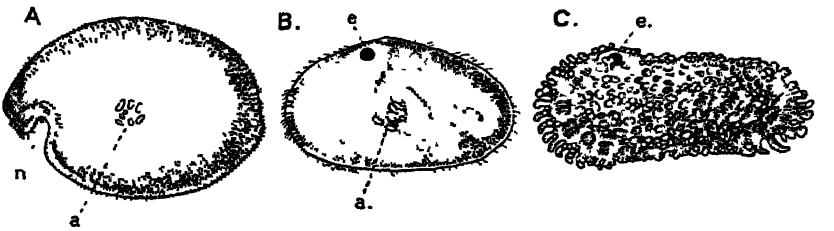


FIG. 10

Shells of Ostracoda, seen from the side. A *Philomedes brenda* (Myodocopa), B *Cypris fuscata* (Podocopa), C. *Cytherets ornata* (Podocopa) all much enlarged. *n*, Notch characteristic of the Myodocopa, *e*, the median eye, *a*., mark of attachment of the muscle connecting the two valves of the shell. A and C. are marine species, B. is from fresh water. (From Lankester's "Treatise on Zoology," after Brady and Norman, and Muller.)

Sub-class III.—COPEPODA.

There are, at most, ten free somites behind the head. The carapace is reduced or absent. The first thoracic limbs form maxilipeds, and are followed by four or five pairs of two-branched swimming feet. The posterior region of the body (the so-called "abdomen") is generally narrowed and is without limbs, but the terminal segment carries a pair of appendages, forming the "caudal fork." Table-case No. 2.

Many Copepoda are found in fresh water, but the majority inhabit the sea, where they are often extremely abundant. They form one of the most important constituents of the "plankton," the assemblage of floating organisms in the waters of the open ocean. Since it is chiefly on this plankton that all the other inhabitants of the sea ultimately depend for food, it may be said that the Copepoda, notwithstanding their small size, play a more

Table-case No. 2. important part in the economy of nature than any other Crustacea

Many Copepoda live as parasites on fishes and other aquatic animals, and as a result of this parasitic life their structure becomes greatly modified and degenerate.

The Order EUCOPEDODA (Fig. 11) includes the great majority of the Copepoda, both free-living and parasitic. True paired compound eyes are never present, but the median unpaired eye is often well-developed. Most of the free-swimming species are extremely minute, few attaining the size of *Euchaeta norvegica*, of which specimens are exhibited. The enlarged drawings show the brilliant colours of some pelagic species.

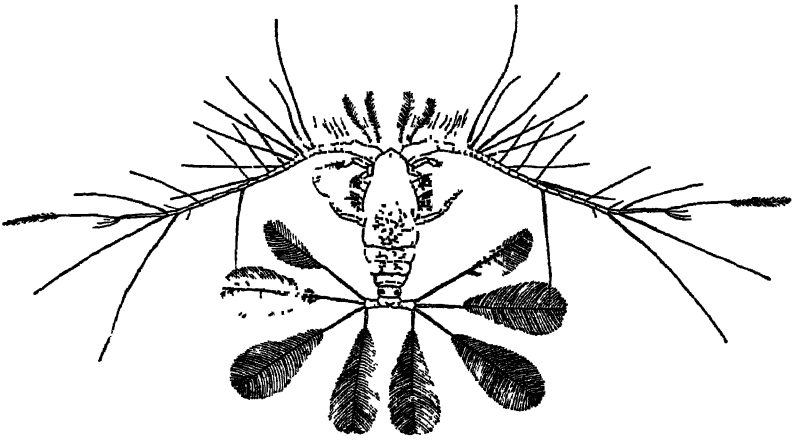


FIG. 11.

Calocalanus pavo, one of the free-swimming Copepoda of the "plankton." Enlarged. (From Lankester's "Treatise on Zoology," after Giesbrecht.)

The parasitic species are usually much larger than those which live a free life, and a number of species taken from common fishes are exhibited. *Pennella*, which is found on whales and fishes, is the giant of the sub-class, some specimens being even larger than that exhibited here.

The order BRANCHIURA includes a small number of fish-parasites whose exact relations to the other Copepods are obscure. They possess a pair of compound eyes, and a piercing stylet, connected with a poison-gland, in front of the mouth. *Argulus foliaceus* is common on fresh-water fishes in this country. The large *Argulus scutiformis* is taken from marine fishes in Japan.

Sub-class IV.—CIRRIPEDIA.

The members of this group are sedentary animals, attached by the anterior part of the head-region, and having the body generally enclosed by a fleshy mantle, representing the carapace, strengthened externally by shelly plates. There are typically six pairs of trunk-limbs, each two-branched and many-jointed. Table-cases Nos. 3 & 4.

On account of their shelly covering the Cirripedia were classed by the older naturalists with the Mollusca, and it was only when their larval stages were discovered in 1829 by J. Vaughan

FIG 12

Group of specimens of a stalked Barnacle (*Lepas anatifera*). One showing the cirri extended as in life. [Table-case No 3

Thompson, that their affinities with other Crustacea were recognised. Nearly all the Cirripedia are hermaphrodite, having both sexes combined in each individual, a condition very rare among the Arthropoda. In some cases, however, there are dwarf male individuals which pair either with females or with hermaphrodites of normal structure.

The Sub-class may be divided into five Orders, but three of these comprise only a few imperfectly-known forms which cannot be exhibited here.

Order 1.—Thoracica.

Table-case No. 3.

This Order includes the typical Cirripedes, in which the six pairs of feathery trunk-limbs are well developed. Two sub-orders are recognised.

In the sub-order PEDUNCULATA (the Stalked Barnacles) there is a fleshy peduncle, or stalk of attachment, at the free end of which is the "capitulum" formed by the mantle enclosing the body and limbs.

Specimens of the common Goose-Barnacle, *Lepas anatifera* (Fig 12), are exhibited showing the external appearance with the

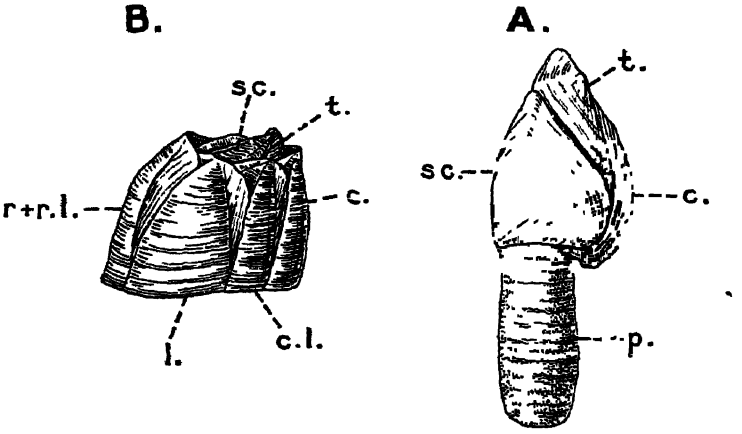


FIG 13.

A A stalked Barnacle (*Lepas anatifera*) B. A sessile Barnacle (*Balanus hameri*). *p.*, The peduncle. The other letters relate to the "valves" or parts of the shell; *c*, carina; *c.l.*, carino-lateral; *l*, lateral, *r* + *r.l.*, rostrum and rostro-lateral fused together; *sc*, scutum; *t.*, tergum. (From Lankester's "Treatise on Zoology," after Darwin.)

feathery "cirri" extended from the opening of the shell, in another specimen half of the shell is removed to show the form of the body and limbs within it; and a third preparation shows the five valves of the shell (Fig. 13A) separated from each other. Like many other barnacles, the species of *Lepas* are commonly attached to floating objects, drift-wood, ships' bottoms, and the like, and most of the species have an extremely wide distribution in all the oceans. The great length sometimes reached by the peduncle of the common goose-barnacle is shown by a fine group of specimens mounted in a jar by the doorway at the south end of the gallery.

Among the other genera of stalked barnacles exhibited, *Polli-*

cipes may be noted as having rows of valves on the capitulum which pass gradually into the small scales covering the peduncle. These scales appear to be the remains of a shelly armour covering the peduncle which was more fully developed in certain extinct genera, and is shown in the casts of the fossil *Loricula* and *Turrilepas* exhibited in this case. The genus *Scalpellum* is of interest not only on account of the deep-sea habitat of many species and the great size of some (*Scalpellum giganteum*), but also and more especially because of the dwarf male individuals already alluded to, which are found in this genus and in the related *Ibla*. In the different species of *Scalpellum* three conditions are represented. In some, all the individuals of a species are similar and hermaphrodite as in ordinary barnacles; in others, as in *Scalpellum peronii*, of which a specimen is shown, the large hermaphrodite individuals have small males attached to them like parasites; in others again the separation of the sexes is complete and the larger individuals are purely female. Table-case No. 3.

Most barnacles are hatched from the egg as actively swimming larvae of a type which is found in many other Crustacea, and is known as the *Nauplius*. They have three pairs of appendages, an unsegmented body, and a conspicuous median eye. Like many other "pelagic" animals the Nauplii of barnacles living at the surface of the ocean often have long spines and outgrowths from the surface of the body, which are probably of service in keeping the animals afloat. A coloured drawing of one of these spiny larvae is exhibited. In its later development the young barnacle passes into a stage in which the body and limbs are enclosed in a bivalved shell like an Ostracod. On account of this resemblance the stage is known as the "*Cypris*" stage, after one of the genera of Ostracoda. After swimming about for some time longer it attaches itself by means of its antennules, casts off its bivalved shell, and gradually assumes the structure of the adult.

The Sessile Barnacles or Acorn-shells, forming the sub-order Operculata (Fig. 13B), agree in most points of structure and development with the stalked barnacles, but they have no peduncle. The shelly plates of the mantle are, for the most part, soldered together to form a cylindrical or conical case, the opening of which is protected by four movable "opercular" plates. In a preparation of *Catophragmus polymerus* here exhibited, names are attached to those parts of the shell which are found (though often reduced in number by coalescence) in all the typical Operculata, the "scutum"

Table-case No 3. and "tergum" forming the movable lid or "operculum," while the others form the outer "wall." In the genus *Catophragmus*, however, there are numerous additional plates outside those which usually form the wall. These outer plates correspond to the additional capitular plates found, among the Pedunculata, in *Pollicipes*, of which a specimen is placed alongside for comparison.

One of the commonest British Barnacles is the little *Balanus balanoides* which is familiar at the seaside, coating rocks and stones as if with "rough cast." At the other extreme of size is another species of the same genus, *Balanus psittacus*, the largest member of the sub-class, of which some fine specimens are exhibited in Wall-case No. 4. It is found on the coasts of Chile, where it is "universally esteemed as a delicious article of food."

Table-case No. 4. Several species of sessile Barnacles are commonly found attached to large marine animals such as whales and turtles The curious *Tubicinella* which burrows into the skin of whales is exhibited here, and a large cluster of *Coronula diadema*, growing on the skin of a whale, is mounted at the side of the doorway at the south end of the gallery.

Darwin's Monograph of the Cirripedia, published 1851–1854, is still the chief work of reference on this group of animals; it is of special interest to the historian of biological theory, because, in the course of its preparation, Darwin had to deal with the problems of specific and individual variation as they present themselves to the systematic zoologist. Like other groups of sedentary organisms, plants and corals for example, the Cirripedia are particularly subject to great variation dependent on differences of environment, and Darwin often found considerable difficulty in deciding as to the limits of species. In Table-case No. 4 is exhibited a small series of specimens selected by Darwin himself to illustrate the variations of *Balanus amphitrite*, and accompanied by a list in his handwriting. Of this species Darwin wrote in his Monograph:—

"In order to show that it has not been from indolence that I have put so many forms together, I may state that I had already named and fully described in detail eight of the following forms as species, when I became finally convinced that they were only varieties. . . . After studying such varying forms as *B. tintinnabulum* and *amphitrite* it is difficult to avoid, in utter despair, doubting whether there be such a thing as a distinct species, or at least more than half a dozen distinct species in the whole genus *Balanus*."

Order 2.—Rhizocephala.

The Rhizocephala are parasites living on other Crustacea, and they offer one of the most striking examples of the degradation in structure associated with the parasitic habit of life. In the adult they lose every trace, not only of Crustacean, but even of Arthropodous structure, although the very close resemblance of their larval stages to those of the normal Cirripedes shows that they have been derived from forms similar to the latter. The body is enclosed in a fleshy mantle, which has a small opening to the exterior. From the short stalk by which the animal is attached, Table-case No. 4.

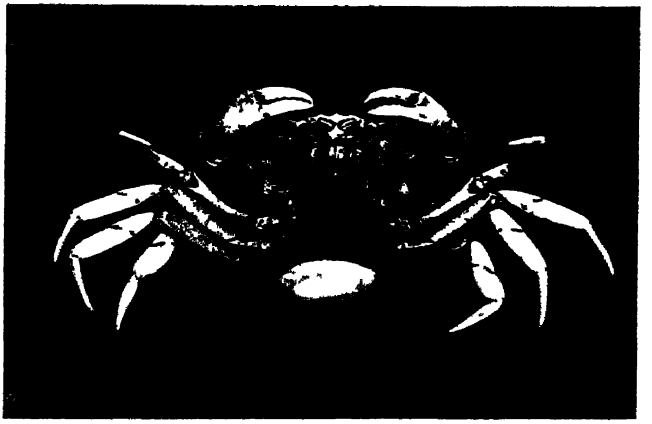


Fig 14

Sacculina carcini attached under the abdomen of a common Shore-crab. [Table-case No 4.]

fine root-like filaments branch in all directions throughout the body of the host (generally a Crab), and serve for the absorption of nourishment. The parasite has no mouth or food-canal, no limbs, and only a feebly developed nervous system

Sacculina carcini, of which a specimen is exhibited (Fig. 14), is found on the common shore-crab (*Carcinus maenas*) and other Crabs.

The remarkable changes which the presence of *Sacculina* induces in its hosts are illustrated by a series of specimens in Wall-case No. 2 already referred to.

In their larval development the Rhizocephala pass through Nauplius and Cypris stages closely similar to those of ordinary barnacles. Drawings of the larval stages of *Sacculina* are exhibited.

Sub-class V.—MALACOSTRACA.

Table-cases Nos. 5–16.

The body consists of nineteen limb-bearing somites (or twenty, if the eye-stalks be reckoned as appendages). A *thorax* of eight and an *abdomen* usually of six somites are sharply distinguished by the character of the appendages

This sub-class is much larger and more varied than any of the others. It may be divided into two series as follows:—

Series 1. LEPTOSTRACA (Abdomen of seven somites).
Division 1. *Phyllocarida.*

Series 2. EUMALACOSTRACA (Abdomen of six somites).
Division 2 *Syncarida.*
„ 3. *Peracarida*
„ 4. *Hoplocarida.*
„ 5. *Eucarida.*

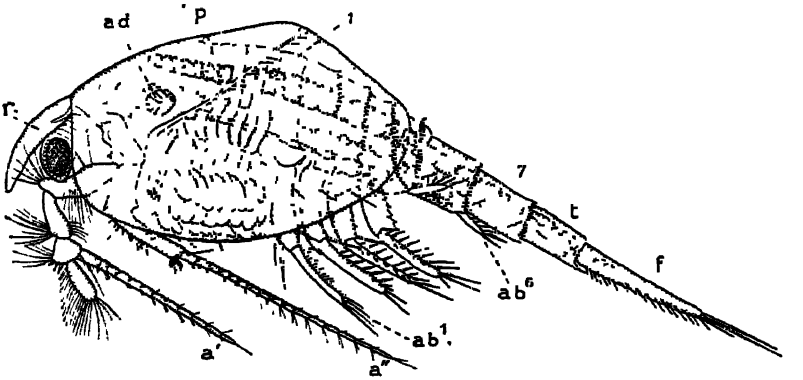


FIG 15.

Nebalia bipes, female, from the side (enlarged). *a.'*, Antennule; *a.''*, antenna; *ab.*¹–*ab.*⁶, the abdominal limbs; *ad*, the adductor muscle joining the two valves of the shell; *f.*, the caudal fork; *p.*, palp of maxillula; *r.*, rostral plate; *t.*, telson; 1–7, the seven somites of the abdomen. (From Lankester's "Treatise on Zoology," after Claus)

Division 1.—PHYLLOCARIDA.

Table-case No. 5.

The carapace is bivalved, enveloping but not coalescing with the thoracic somites, and bearing in front a movably articulated rostral plate. The eyes are stalked. The last somite of the abdomen has no limbs, but the telson carries a pair of appendages forming the "caudal fork." The thoracic limbs are flattened and leaf-like.

The existing species belonging to this division are few in number but are very widely distributed in all seas. *Nebalia bipes*,

of which a specimen is exhibited, occurs on the British coasts and ranges from Greenland to Chile and Japan. A coloured drawing of a living *Nebalia* is hung in Wall-case No. 4. Table-case No. 5.

It is probable that the fossil forms known as the *Ceratiocaridae*, which are abundant in many rocks of Palaeozoic age, should be referred to this division.

Division 2.—SYNCARIDA.

There is no carapace, and all the thoracic somites (except, sometimes, the first) are distinct. The eyes may be stalked or sessile. The thoracic limbs carry exopodites and a double series of plate-like gills.

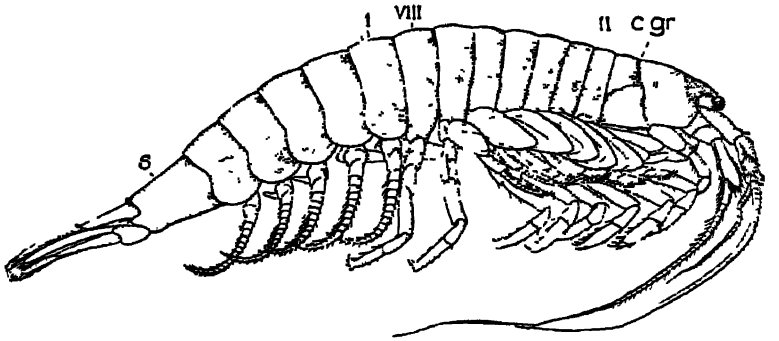


FIG. 16.

Anaspides tasmaniae, male, from the side (slightly enlarged). *c gr.*, "Cervical groove" marking off the first thoracic somite, II–VIII, the remaining thoracic somites; 1–6, the abdominal somites [Table-case No 5]

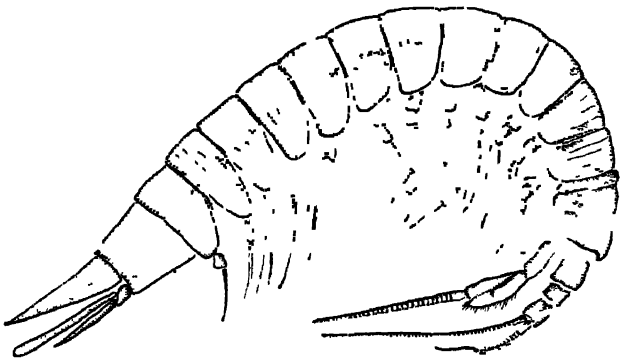


FIG. 17.

Praeanaspides praecursor, from the Coal Measures of Derbyshire.

Table-case No. 5.

This division includes, among living Crustacea, a small number of very peculiar forms recently discovered in the fresh waters of Tasmania and Victoria (Fig. 16). They are of special interest on account of the fact that they appear to be survivors of an ancient group of Crustacea of which the remains are found fossil in Carboniferous and Permian rocks. The drawing of the fossil *Praeanaspides praecursor* (Fig. 17), exhibited in the case, shows the great resemblance in general form between that species and the recent *Anaspides* (Fig. 16).

Division 3.—PERACARIDA.

The carapace, when present, does not coalesce dorsally with more than four of the thoracic somites. The eggs and young are

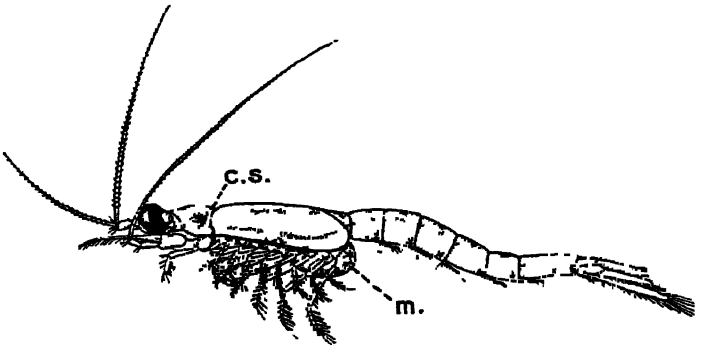


FIG. 18

Mysis relicta, female, from the side. *c.s.*, "Cervical groove"; *m*, Brood-pouch. (From Lankester's "Treatise on Zoology," after Sars.)

carried in a brood-pouch formed by overlapping plates attached to the bases of the thoracic limbs.

The following Orders are included in this division.—

Order 1. *Mysidacea.*
„ 2. *Cumacea.*
„ 3. *Tanaidacea.*
„ 4. *Isopoda.*
„ 5. *Amphipoda.*

Order 1.—Mysidacea.

The general form is shrimp-like (Fig. 18) A carapace is present, but it leaves free at least five of the thoracic somites.

The eyes, when present, are stalked and movable. There are swimming branches (exopodites) on the thoracic legs. Table-case No. 5.

Most of the Mysidacea live in the sea and many species are found on the British coasts. *Macromysis flexuosus* is one of the commonest species. A coloured drawing of the closely allied *Leptomysis* is hung in Wall-case No. 5. A drawing of *Arachnomysis leuckarti* in the Table-case gives an example of the remarkable forms assumed by some deep-sea members of the Order. The family *Lophogastridae*, all of which are inhabitants of the deep sea, reach a much greater size than do the members of the other families. A specimen of *Gnathophausia calcarata* from the "Challenger" expedition is exhibited, and alongside of it is placed

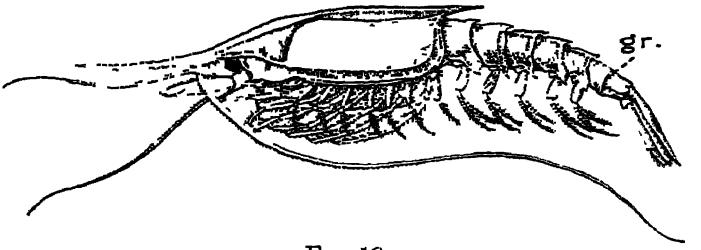


FIG 19.

Gnathophausia willemoesii, female, from the side, one-half natural size *gr.*, a groove dividing the last abdominal somite. (From Lankester's "Treatise on Zoology," after Sars)

a copy of a coloured drawing from a living specimen of *G. willemoesii* (Fig. 19), showing the vivid red coloration characteristic of many deep-sea Crustacea

Order 2.—Cumacea.

A carapace is present, but it leaves four or five of the posterior thoracic somites free. The eyes are not stalked, and are usually coalesced into one Swimming branches (exopodites) are usually present on some of the thoracic limbs. The abdomen is generally very slender, and the last pair of appendages (uropods) are elongated. The other abdominal appendages are absent, at least in the female.

The Cumacea are all marine, burrowing in sand and mud, and being occasionally taken in great numbers swimming at the surface of inshore waters As a rule, they are very small, the specimens of the common British species *Iphinoë trispinosa* here

Table-case No. 5.

shown being perhaps larger than the average, but in Arctic seas, where they are especially abundant, they often attain a much greater size, as is shown by the specimen of *Diastylis goodsiri* (Fig. 20) from the Kara Sea.

FIG. 20.

Diastylis goodsiri, female, from the side, enlarged. *a.'*, antennule; *l.*^{1}–*l.*^{5}, the five pairs of walking-legs; *m.*, brood-pouch; *ps.*, "pseudo-rostrum," formed by lateral plates of the carapace; *t.*, telson; *ur.*, uropods. (From Lankester's "Treatise on Zoology," after Sars.)

Order 3.—Tanaidacea.

Table-case No. 6.

Six of the thoracic somites are always distinct, the reduced carapace involving only the first and second (Fig. 21). On each side the overhanging carapace encloses a cavity within which lies

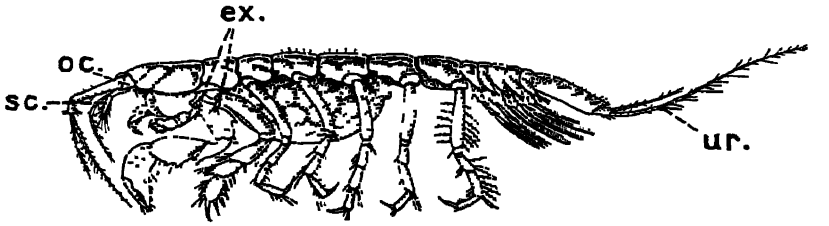


FIG. 21.

Apseudes spinosus, female, from the side, enlarged. *ex.*, vestiges of exopodites on second and third thoracic limbs; *oc.*, the small and immovable eye-stalks; *sc.*, scale or exopodite of antenna; *ur.*, uropod. (From Lankester's "Treatise on Zoology," after Sars.)

(as in the Cumacea) a branchial appendage attached to the first thoracic limb. The second thoracic limb is chelate or pincer-like, and the second and third may carry minute vestiges of swimming-branches (exopodites) (Fig. 21, *ex.*). The eyes, when present, are set on small and immovable stalks (Fig. 21, *oc.*).

The Tanaidacea, which are all marine, and generally of very small size, are of great interest as preserving, along with the Cumacea, links of connection between the stalk-eyed or "podophthalmate" type of the Mysidacea and the sessile-eyed or "edriophthalmate" Isopoda and Amphipoda. Table-case No. 6.

Order 4.—Isopoda.

There is no distinct carapace. As a rule, only the first thoracic somite is fused with the head, and the other seven are

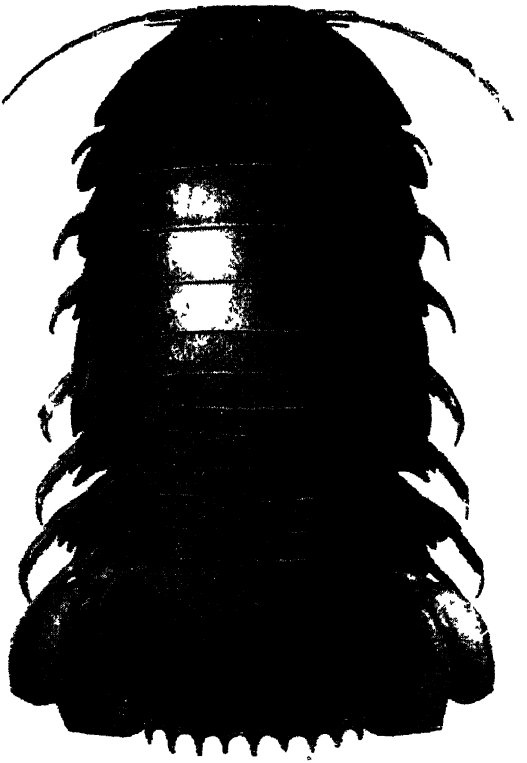


FIG. 22.

Bathynomus giganteus, about one-half natural size. (From Lankester's "Treatise on Zoology," after Milne-Edwards and Bouvier.) [Table-case No. 6.]

free. There are no exopodites on the thoracic limbs. The eyes, when present, are sessile. The body is usually flattened from above downwards. The abdominal appendages are lamellar and respiratory.

Table-case No. 6.

This is a very large and varied group, comprising numerous families which are grouped under six Sub-orders.

In the Sub-order ASELLOTA the uropods are slender; the basal segments of the legs are not coalesced with the body as in most other Isopoda; the first pair of abdominal limbs are generally fused, in the female, to form an operculum, or cover for the remaining pairs. This group includes *Asellus aquaticus*, which is common everywhere in ponds and ditches in this country, and a very large number of marine species, mostly of small size.

The Sub-order PHREATOICIDEA includes a small number of very peculiar species found in fresh water in Australia and New Zealand. In these the body is flattened from side to side, and the animals in other respects have a superficial resemblance to Amphipoda.

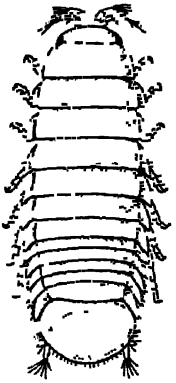


FIG. 23.

Limnoria lignorum, much enlarged. (After Sars.) [Table-case No. 6.]

In the Sub-order FLABELLIFERA the terminal limbs of the abdomen (uropods) are spread out in a fan-like manner on each side of the telson. Many species of this group, belonging to the family *Cymothoidae*, are blood-sucking parasites of fish, and some of them are remarkable for being hermaphrodite (like the Cirripedia), each animal being at first a male and afterwards a female. This family includes the giant of the Order, the deep-sea *Bathynomus giganteus* (Fig. 22), which sometimes reaches an even greater size than the specimen exhibited.

A contrast in point of size is provided by the minute *Limnoria lignorum* (Fig. 23), belonging to the family *Sphaeromidae*, which, however, forces itself upon human attention by reason of its destructive powers. In company with a member of the next Order, the Amphipod *Chelura terebrans*, it burrows in submarine timber, and by their enormous numbers the two species often destroy the piles of jetties and such-like structures to an extent which is only paralleled by the havoc wrought on land by the "White ants" of tropical countries. A good example of the results of their activity is given by a piece of timber from Ryde pier exhibited in Wall-Case No. 4 (Fig. 24).

The Sub-order VALVIFERA is characterised by the fact that the uropods form a pair of plate-like "valves" closing over the remaining five pairs of abdominal appendages. This Sub-order

includes the species of *Idotea* common on the British coasts, one of which is shown in a coloured drawing hung in Wall-case No. 6. The family *Arcturidae* are remarkable for the long and sub-cylindrical body, very unlike that of the ordinary Isopods, and also for the great size of the antennae, on which the young cluster as in the specimen of *Arcturus baffini* (Fig. 25) exhibited here. Table-case No. 6.

The Sub-order ONISCOIDEA comprises the familar "Woodlice"

FIG 24

Piece of timber from Ryde pier, [illegible] mage caused by *Limnoria* and *Chelura* [illegible] No. 4]

or "Slaters" so common in gardens. They are terrestrial animals adapted for breathing air, and sometimes having, in the abdominal limbs, tufted air-tubes like the "tracheae" of insects, which serve as respiratory organs. The terminal limbs of the abdomen are slender or minute, and the antennules are always small. The large "Sea-slater," *Ligia oceanica*, which is always found near the sea and sometimes actually *in* rock pools, is intermediate in many points of structure, as it is in habits, between the exclusively

Table-case No. 6.

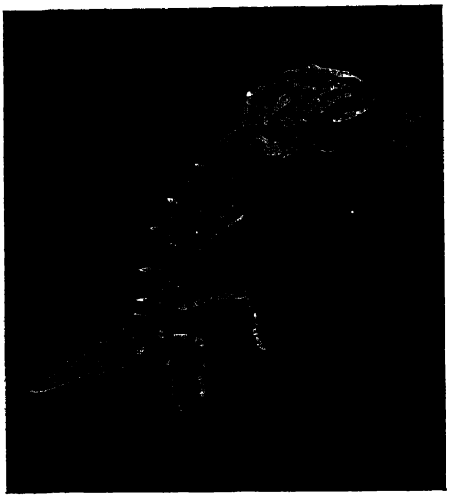


FIG. 25.

Arcturus baffini, female, carrying a cluster of young ones on its antennae. [Table-case No. 6.]

terrestrial species and their marine relatives. *Porcellio scaber* (Fig. 26) is one of the very common garden species.

The Isopods belonging to the Sub-order EPICARIDEA are all parasitic on other Crustacea, and their structure presents, in the adult state, a great variety of modifications. The two sexes are often very dissimilar in size and shape, and some species are hermaphrodite. A specimen of the common Prawn (*Leander serratus*) is exhibited which has, on one side of the carapace, a swelling due to the presence in the gill-chamber of the parasite *Bopyrus squillarum*. The female of the parasite, taken out of the gill-chamber, is shown alongside. The male, in this species, is almost microscopic in size, and is commonly found clinging to the under side of the female.

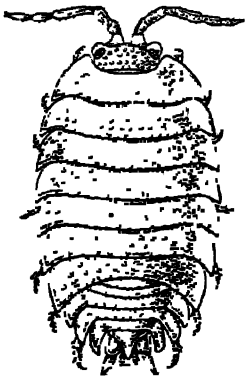


FIG. 26.

Porcellio scaber, female, dorsal view, enlarged. (From Lankester's "Treatise on Zoology," after Sars.)

A still more remarkable form is shown in the drawings of *Portunion maenadis*, a parasite of the common Shore-crab, *Carcinus maenas*. The figure on the right

shows the parasite *in situ* in the shell of the crab. The yellow mass is the greatly developed brood-pouch, which is distended with eggs. The figure on the left represents a younger specimen removed from the crab and further enlarged. The flaps of the empty brood-pouch have been turned back. Table-case No. 6.

Order 5.—Amphipoda.

As regards the segmentation of the body, the sessile eyes, and some other characters, the members of this Order agree with the Table-case No. 7.

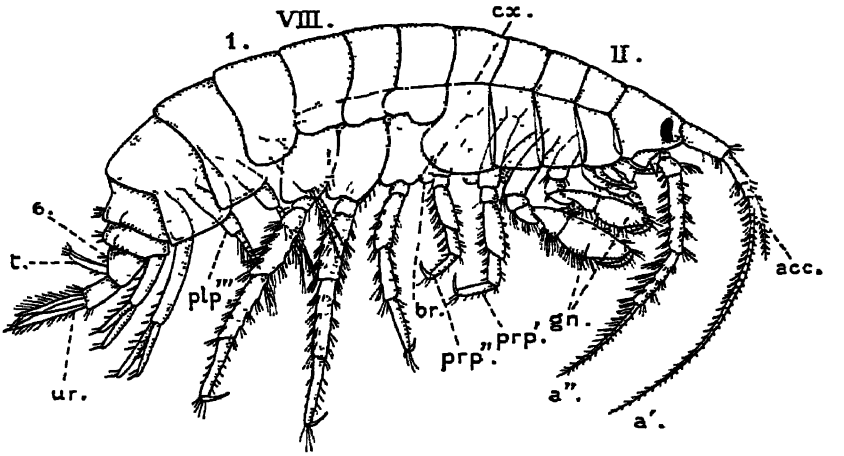


FIG. 27.

Gammarus locusta, male, from the side, enlarged *a'*, antennule, *a''*, antenna; *acc*, accessory (inner) flagellum of antennule; *br*, gill-plate, *cx*, coxal plate (the expanded first segment of the leg; *gn*, the two pairs of "gnathopods" (prehensile legs); *plp'''*, abdominal appendage of third pair; *prp'*, *prp''*, first and second peraeopods or walking-legs; *t*, telson; *ur*, uropod; II., VIII., second and eighth thoracic somites; 1, 6, first and sixth abdomina lsomites. (From Lankester's "Treatise on Zoology," after Sars.)

Isopoda, but the body is usually compressed from side to side, the abdominal appendages are not respiratory, and there are gill-plates attached on the inner side of the bases of some of the thoracic limbs.

The Amphipoda are grouped under three Sub-orders.

In the Sub-order GAMMARIDEA are included the typical Amphipoda, in which the body is more or less stout, the abdomen well developed, and the eyes generally small. The most familiar members of this Sub-order are perhaps the Sandhopper, *Talitrus saltator*, and the Shorehopper, *Orchestia gammarellus*. These two

Table-case No 7. species are exceedingly common all round our coasts. They are almost terrestrial in their habits, burrowing in the sand above high-water mark, and sometimes at a little distance from the sea. The two are often found together, and it is perhaps incorrect to imply that they are distinguished in popular speech, but *Talitrus* is stated to be more common on sandy beaches, while *Orchestia* is often found among rocks.

More typical representatives of the Gammaridea, however, are

FIG. 28.

Aegina spinosissima, one of the Caprellidae, slightly reduced [Table-case No. 7.]

the numerous species of *Gammarus*, of which some live in the sea and others, like the very common *Gammarus pulex* of this country, in fresh water. Specimens and a drawing of *Gammarus locusta* (Fig. 27) are shown in this case and a coloured drawing of the same species, from life, is hung in Wall-case No. 6.

Of the other Gammaridea exhibited, it need only be said that some, like *Eurythenes gryllus* and *Stegocephalus ampulla*, show the large size reached by some species in Arctic Seas, where they swarm in extraordinary profusion; that *Acanthogammarus godlewskii* is one of a host of remarkable species, all closely related

to the common *Gammarus*, found in Lake Baikal; and that the little *Chelura terebrans* is, of all Amphipoda, perhaps the most directly important to man on account of its destructiveness to marine timber referred to above (p. 42). Table-case No. 7.

The members of the Sub-order HYPERIIDEA can generally be recognised by the very large eyes, which may cover almost the whole surface of the head. The first thoracic limbs (maxillipeds) are reduced. Most of the species are pelagic in habit, living at the surface of the open sea. One of the most remarkable is *Phronima sedentaria* which lives on various pelagic organisms, like jelly-fishes and salps, and often carries about with it as a kind of cloak the remains of its prey. One of the two specimens here shown is enclosed in a barrel-shaped case, the remains of a swimming-bell of one of the Siphonophoran jelly-fishes.

In the Sub-order CAPRELLIDEA the body is either slender and thread-like (Caprellidae), or broad and flattened (Cyamidae). The abdomen and its limbs are vestigial.

The *Caprellidae* (Fig. 28) are generally found among Zoophytes or seaweeds. A group of specimens mounted in natural surroundings is shown in Wall-case No 4.

The *Cyamidae*, or "Whale-Lice," are parasitic on Whales, and are sometimes found in large numbers clinging to their skin

Division 4.—HOPLOCARIDA.

Four or five of the posterior thoracic somites are free from the carapace. There is no brood-pouch. Two movable segments are separated from the anterior part of the head, bearing respectively the pedunculate eyes and the antennules, and there is a movable rostral plate in front of the carapace. The first five pairs of thoracic limbs are subchelate, and the second pair are very large. The last three pairs carry exopodites. There are tufted gills borne by the first five pairs of abdominal appendages. Table-case No. 8.

This division includes the single order STOMATOPODA, the members of which are abundant in the warmer seas. They are generally easily recognised by the characteristic form of the large claws, which are not pincer-shaped, like those of Lobsters and Crabs, but have the last segment shutting down, like a knife-blade, on the segment before it.

One species of *Squilla* (*S. desmarestii*) occurs occasionally

Table-case No. 8.

on the South Coast of England, and the much larger *S. mantis* (Fig. 29), of which specimens are exhibited from the Mediterranean, has been found, very rarely, off the coast of Cornwall. Both species are used for food in Mediterranean countries.

The Stomatopoda have a prolonged larval development, in the

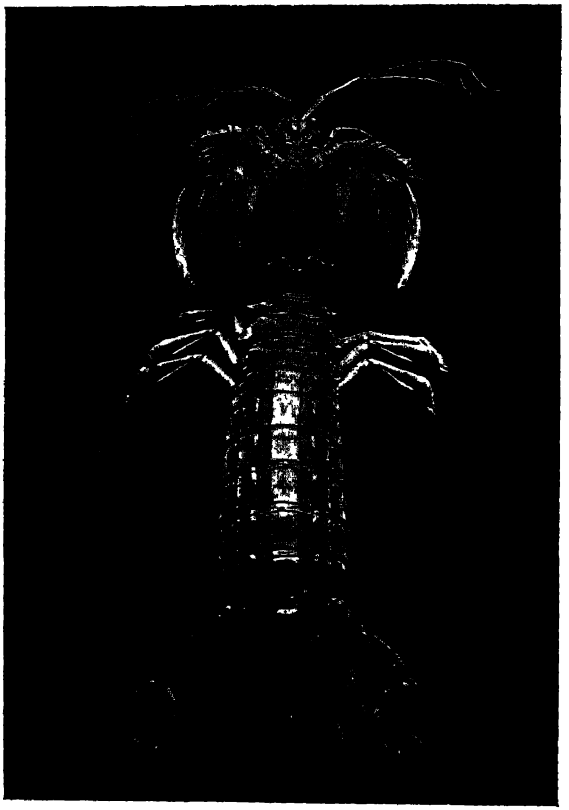


FIG. 29.

Squilla mantis, about one-half natural size. [Table-case No. 8.]

course of which the larvae assume very striking forms, and often attain a large size. They were formerly supposed to be independent species of Crustacea, and received the generic names of *Erichthus*, *Alima*, etc. The "species" *Lysioerichthus edwardsii*, of which a specimen is exhibited, has been found to be the larval state of *Lysiosquilla glabriuscula*.

Division 5.—EUCARIDA.

The carapace is coalesced dorsally with all the somites of the thorax. There is no brood-pouch. Table-case No. 8.

Two Orders of very unequal size are included in this Division :—

Order 1.—*Euphausiacea.*
„ 2.—*Decapoda.*

Order 1.—Euphausiacea.

The members of this Order were formerly included with the Mysidacea in the Order "SCHIZOPODA." They are, however, very closely allied to the Decapoda, and are distinguished from the

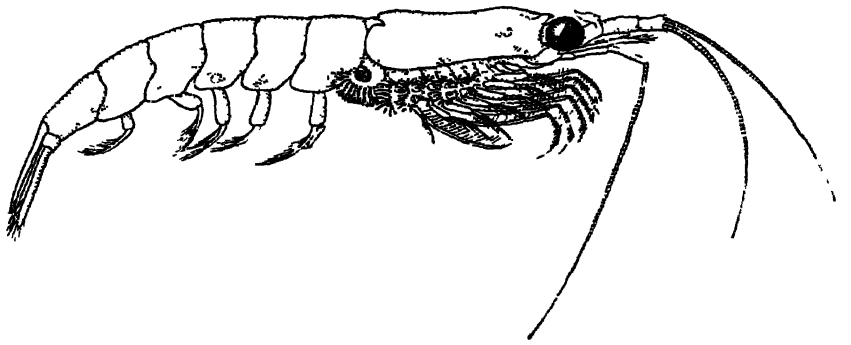


FIG. 30

Meganyctiphanes norvegica, male, from the side, about twice natural size. (From Lankester's "Treatise on Zoology.")

more primitive types of that Order chiefly by the fact that they possess only a single series of gills (podobranchiae), and that none of the thoracic limbs are distinctly modified as maxillipeds.

Most of these animals, like some of the lower Decapods, are phosphorescent. The light-producing organs, situated on various parts of the body and limbs, were formerly described as "accessory eyes"; they are seen as little red spots along the sides of the body in the coloured drawing of *Nematoscelis microps* exhibited in this case.

Meganyctiphanes norvegica (Fig. 30), one of the larger species of the Order, occurs in deep water off the British coast. In Loch Fyne, where the specimens here exhibited were obtained, the species forms an important food of the herring.

Order 2.—Decapoda.

Table-cases Nos. 9–16.

The gills are arranged typically in three series—podobranchiae, arthrobranchiae, and pleurobranchiae. Only in the aberrant genus *Leucifer* are the gills entirely absent. The first three pairs of thoracic limbs are more or less completely modified to act as jaws (maxillipeds), while the last five form the legs.

This very extensive and varied Order includes all the larger and more familiar Crustacea, such as Crabs, Lobsters, Crayfish,

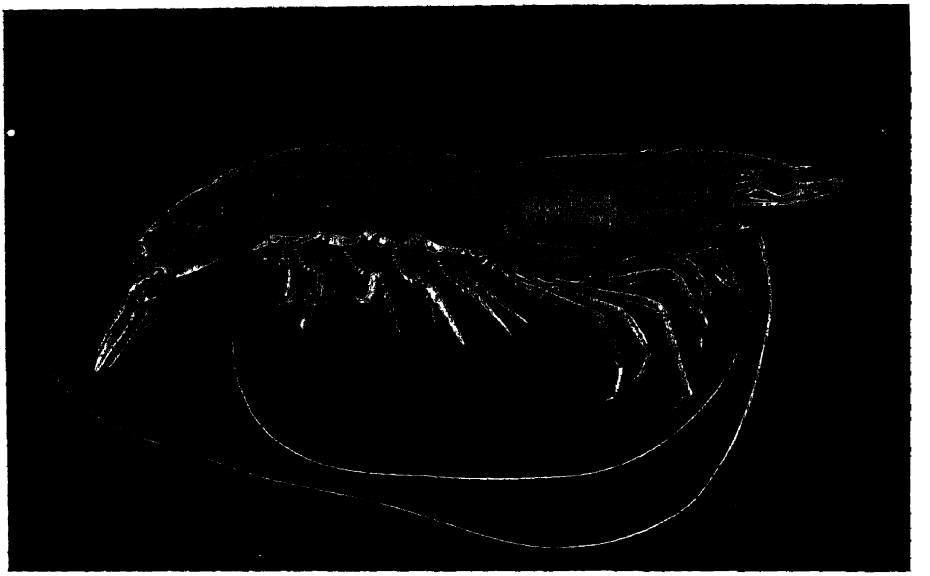


FIG. 31.

Penaeus caramote, from the side, about half natural size.
[Table-case No 9]

Prawns, and Shrimps. From their greater size and more general interest, it is both possible and desirable to exhibit a much larger series than in the other groups of Crustacea, and in Table-cases Nos. 9 to 16 will be found representatives of all the Tribes and of the more important families composing the Order. On the system of classification adopted here, these tribes are grouped under three Sub-orders :—

Sub-order 1.—Macrura.
„ 2.—Anomura.
„ 3.—Brachyura.

Sub-order I.—MACRURA.

The Macrura are generally distinguished by the large size of the abdomen, which is symmetrical and not folded under the body. The front, or rostrum, is not united with the "epistome." The sixth pair of abdominal appendages (uropods) are always present, generally broad and flattened, forming with the telson, a "Tail-fan." Table-cases Nos. 1–16.

The first Tribe of the Macrura, the Penaeidea, consists of prawn-like animals having the first three pairs of legs usually chelate or pincer-like, and not differing greatly in size. The side-plates of the second abdominal somite do not overlap those of the first. Members of this Tribe are the commonest Prawns in tropical seas, and often reach a great size. *Penaeus caramote* (Fig. 31) is highly esteemed for the table in Mediterranean countries, and many other species are used for food in various parts of the world. *P. caramote* is stated to have occurred on the Welsh coast. *Leucifer*, a delicate, transparent, pelagic form, belonging to this tribe, differs from all other Decapoda in having no gills Table-case No. 9.

The small Tribe of the Stenopidea includes a few forms which resemble the Penaeidea and the Astacidea in having the first three pairs of legs chelate, but differ from them, among other characters, in the fact that the third pair is much the largest. *Stenopus*, a common tropical genus, is remarkable for the brilliant coloration of the living animals. The specimen of *S. hispidus* exhibited here has been painted so as to convey some impression of this.

The Tribe Caridea includes the true Prawns and Shrimps. The first two pairs of legs are generally chelate or pincer-like, and the first is seldom larger than the second. The second somite of the abdomen has the side-plates broadened, so as to overlap those of the somites in front and behind.

Only a few of the numerous families composing this tribe are illustrated by the specimens exhibited.

The members of the family *Acanthephyridae* are deep-sea animals, and possess many primitive characters. Like some of the related families, they have swimming branches (exopodites) on the legs. Some of them are phosphorescent.

The *Nematocarcinidae* are also inhabitants of the deep sea, and are remarkable for the extreme length and slenderness of the legs,

Table-case No. 9. well shown by the specimen of *N. undulatipes* (Fig. 32) from the *Challenger* Expedition, which is exhibited here.

The *Pandalidae* have the first pair of legs slender and ending in pincers so minute that, to the naked eye, the limbs appear simply pointed. The second legs have the carpus, or "wrist," divided into small segments. To this family belong the British *Pandalus montagui* (the "Pink Shrimp" of the fishmonger) and

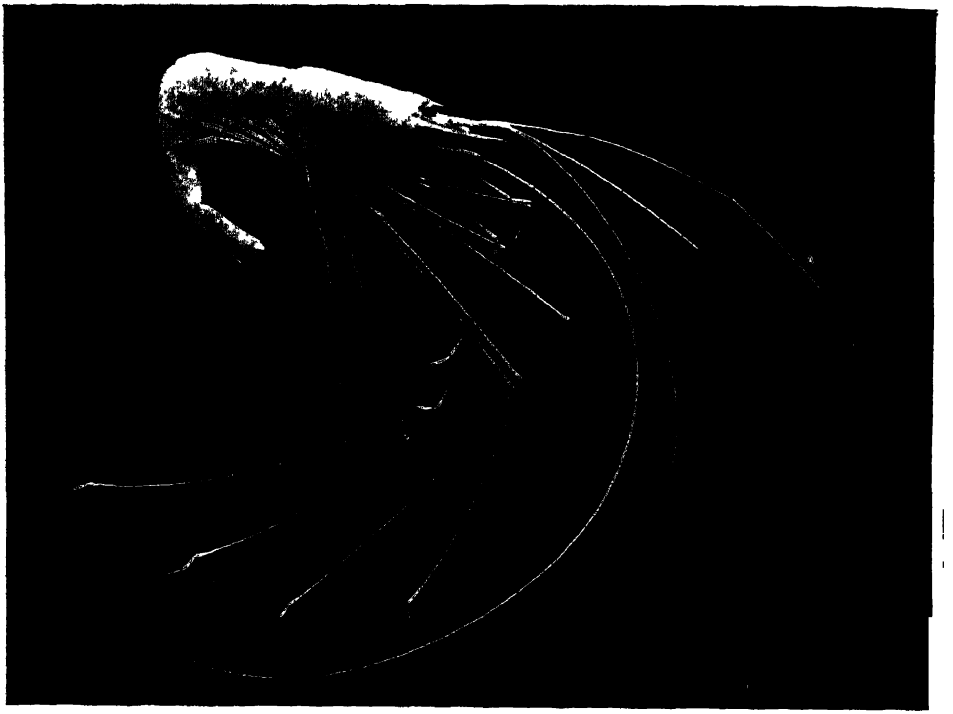


FIG. 32.

Nematocarcinus undulatipes. [Table-case No 9.]

the much larger *P. borealis*. The latter inhabits the deeper waters of some of the Norwegian fjords, ranging from 60 to 400 fathoms depth. In recent years, as a direct result of investigations carried out by the zoologists of the Norwegian Fishery Department, an important fishery of this species has been established, and large quantities are now exported from Norway to the English and other markets.

In the family *Alpheidae* the pincers of the first pair of legs are

usually greatly enlarged and very dissimilar in shape. The second legs are slender, and have the carpus, or "wrist," divided into many small segments. The members of this family are very abundant in tropical seas, especially on coral reefs. Some of them produce a clicking noise by snapping the fingers of one of the chelae. Table-case No. 9.

In the family *Palaemonidae* the first two pairs of legs end in chelae, or pincers; the second pair is larger than the first, and has the carpus, or "wrist," undivided. The antennules bear each three terminal filaments. To this family belong the common marine "Prawns" of British coasts and the "River-Prawns" that are abundant everywhere in fresh waters within the tropics. The great size reached by some of the latter is shown by the specimens of *Palaemon carcinus* from the East Indies and *P. jamaicensis* from

FIG. 33.

The common Prawn, *Leander serratus*, slightly reduced [Table-case No. 9.]

the West Indies. Attention may also be directed to a specimen of the common Prawn (*Leander serratus*) (Fig. 33) prepared by a special process so as to retain the translucency of the living animal.

In the family *Crangonidae* the pincers of the first pair of legs are imperfectly formed (sub-chelate) and much stronger than those of the second pair, which are very slender. The rostrum is usually short and flattened. To this family belong the common Shrimp (*Crangon vulgaris*) and the large Arctic Shrimp (*Sclerocrangon boreas*).

The Tribe ASTACIDEA (or NEPHROPSIDEA) includes the true Lobsters and Crayfishes. They may be recognised by having the first three pairs of legs chelate or pincer-like, and the first pair very large. Table-case No. 10.

The Lobsters constitute the family *Homaridae*, all the members of which inhabit the sea. The last thoracic sternite is firmly fixed

Table-case No. 10

to the preceding, and the male has sexual appendages on the abdomen.

The common Lobster of Europe, *Homarus gammarus*, is represented on the American coasts of the North Atlantic by a closely allied species, *H. americanus*. A third species, *H. capensis*, is

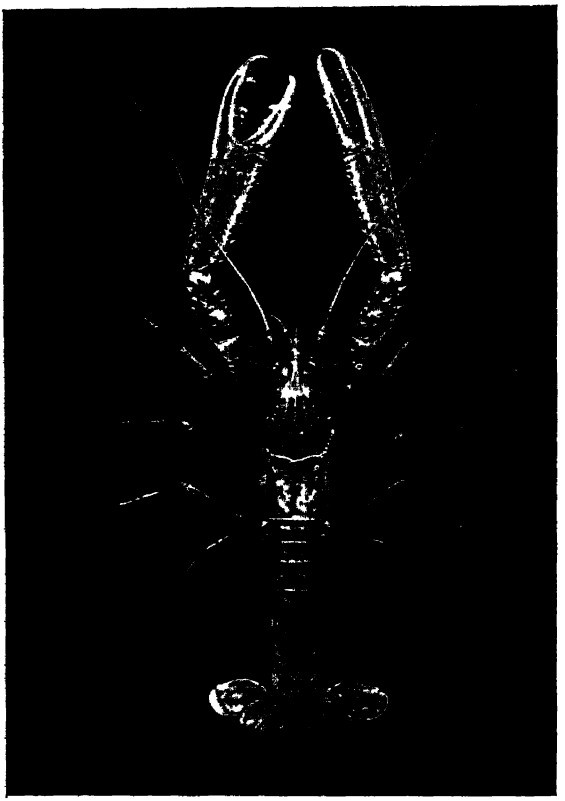


FIG. 34.

The "Norway Lobster," *Nephrops norvegicus*, about one-third natural size. [Table-case No. 10.]

found at the Cape of Good Hope, but it is of small size and of no economic importance. A series of specimens and drawings in Wall-cases Nos. 1 to 3, illustrating the structure and life-history of the Common Lobster, have already been described. The "Norway Lobster," *Nephrops norvegicus* (Fig. 34), is found abundantly in certain localities in deeper water than that frequented by the Common Lobster. It is generally sold in London shops

under the name of "Dublin Prawn," although the chief supplies now come from Scotland and the North-East of England, not, as formerly, from the Irish Sea. In connection with the name "Norway Lobster" used for this species, it should be remembered that the common Lobster is abundant on the coasts of Norway, and that large quantities are exported thence to England. Table-case No. 10.

In the true Crayfishes, which belong to two families inhabiting respectively the fresh waters of the Northern and Southern Hemi-

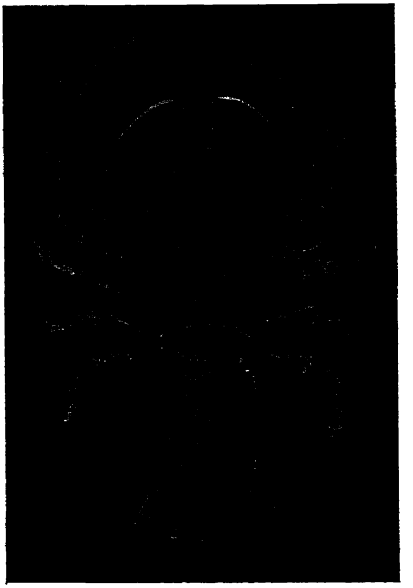


FIG. 35.

Astacopsis franklinii, about $\frac{1}{7}$th natural size. [Wall-case No 5.]

spheres, the last thoracic sternite is movable. In the Northern Crayfishes, belonging to the family *Astacidae*, the male has sexual appendages on the abdomen.

The largest of the Crayfishes found in Western Europe, and the most highly esteemed for food, is the "Red-clawed Crayfish," *Astacus fluviatilis* (French, "Écrevisse à pattes rouges," German, "Edelkrebs"), found in France, Germany, Austria, N.W. Russia, S. Sweden, Denmark, &c. Although the name *A. fluviatilis* is sometimes applied to the English Crayfish, it is more correctly restricted to the Red-clawed species, which does *not* occur in the British Islands.

Table-case No 10. The "White-clawed Crayfish," *Astacus pallipes* (French, "Écrevisse à pattes blanches," German, "Steinkrebs"), is found in England and Ireland, France, South Germany, Italy, &c. It is little used for food, being regarded as much inferior to *A. fluviatilis*.

Astacus leptodactylus is a large species found in the Lower Danube and its tributaries, and in Russia, especially in those rivers that flow into the Black Sea and the Caspian. It is occasionally used for the table, but is regarded as inferior in quality.

In North America, east of the Rocky Mountains, numerous species of crayfish of the genus *Cambarus* are found. A few of these live in the subterranean waters of caves, and, like many other subterranean animals, are blind. The best known species is *Cambarus pellucidus*, from the Mammoth Cave in Kentucky, of which a specimen is exhibited.

In the Southern Crayfishes, forming the family *Parastacidae*, there are no sexual appendages in the male. Numerous species of this family occur in Australia, and *Astacopsis spinifera*, known as the "Murray River Lobster," is used for food. Like the closely allied *A. franklinii* (Fig. 35) of Tasmania (of which a specimen is exhibited in Wall-case No. 5), it sometimes grows to a great size. The occurrence of *Astacoides madagascariensis* on the island of Madagascar is remarkable, since no Crayfishes are found anywhere on the African continent.

Table-case No 11. The members of the tribe LORICATA (or SCYLLARIDEA) are large, lobster-like Crustacea. They may be distinguished from the true lobsters by having no chelae (the last pair of legs only are imperfectly chelate in the female). In the family *Palinuridae* the body is more or less cylindrical, and the antennae are long, cylindrical and jointed, while in the *Scyllaridae* the body is more or less flattened, and the antennae are expanded into broad plates, which are said to be used as shovels in burrowing. To the former family belongs the Spiny Lobster or Sea Crawfish (French, "Langouste"), *Palinurus vulgaris* (Fig. 36), which is found on the Southern and Western coasts of the British Islands, and of which two large specimens are mounted in Wall-case No 6. Numerous species of Spiny Lobsters occur in the warmer seas, and they are used for food in many parts of the world. The brilliant colouring of many tropical species is illustrated by a specimen of *Panulirus ornatus* coloured as in life. The only species of the Scyllaridae found in British waters is *Scyllarus arctus* (*Arctus ursus*) of which a Mediterranean specimen is exhibited. It occurs, rarely, off the south-western coasts of England.

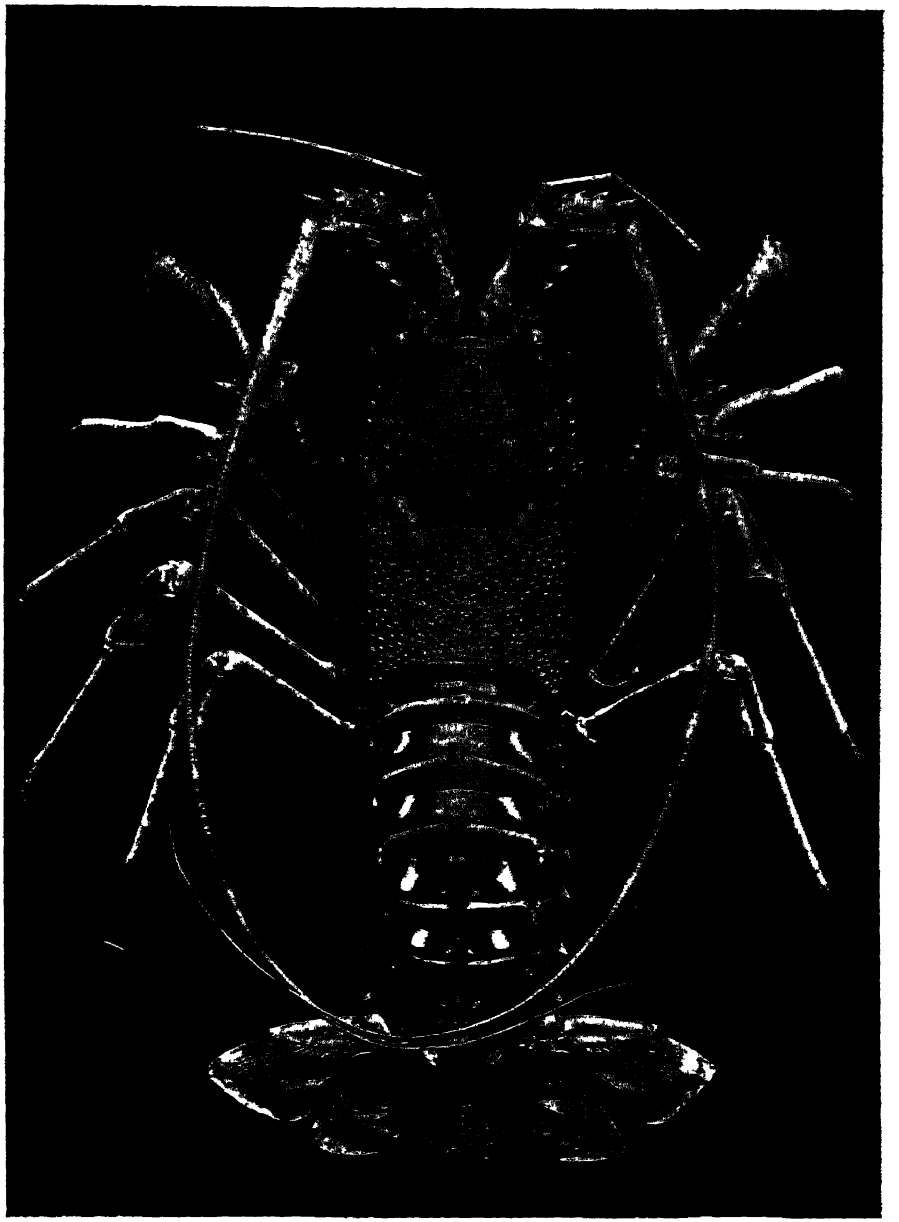


FIG. 36.

The common Spiny Lobster, *Palinurus vulgaris*, much reduced.
[Wall-case No. 6.]

Table-case No. 11.

The larvae of the Loricata are very unlike those of the related groups, and are remarkable for their extremely flattened form and glassy transparency, and for the large size which they sometimes attain. They were formerly regarded as adult and independent species of Crustacea, and received the generic name of *Phyllosoma* (Fig. 37).

Representatives of the extinct family *Glyphacidae* are found fossil in rocks of Mesozoic age, from the Trias onwards. In some

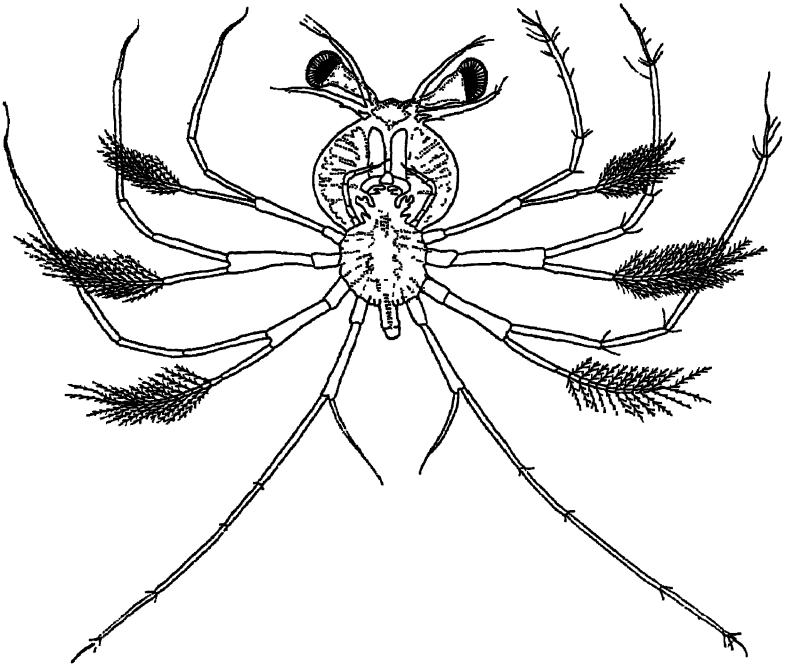


FIG. 37

The "*Phyllosoma*" larva of the common Spiny Lobster, much enlarged. (After J. T. Cunningham.)

characters, such as the possession of a scale or exopodite on the antenna, and sometimes in having true chelae, they are much more primitive than the existing Loricata. A drawing of *Glyphaea regleyana* from the Jurassic of France is exhibited.

In the Tribe ERYONIDEA the first four, and sometimes all five, pairs of legs are provided with chelae. Special interest attaches to this tribe on account of its geological antiquity. Fossil forms, not very different from those now living, are found in rocks of Mesozoic age, from the Trias onward.

The existing species are confined to the deep sea, and, like many other deep sea animals, are blind. Some, at least, are phosphorescent, and a living example of *Polycheles phosphorus* (of which a specimen is exhibited) (Fig. 38) was observed by Dr. Alcock to be "luminous at two points between the last pair of thoracic legs where there is a triangular glandular patch." A copy of a drawing made from a living specimen of another species, *Polycheles sculptus*, dredged at a depth of 695 fathoms in the Gulf of Panama, shows the red coloration that is very characteristic of deep-sea Crustacea. Table-case No 11

The fossil species are represented by a cast of *Eryon arctiformis*, from the Lithographic limestone (Jurassic) of Solenhofen in Bavaria.

The members of the tribe THALASSINIDEA are burrowing forms, with a soft, loosely built body. They form, in some respects, a transition to the Anomura, in which, in some systems of classification, they are included.

In the genus *Callianassa*, of which one species, *C. subterranea*, occurs on the south coast of England, one of the chelae of the first pair of legs is much larger than the other and is of peculiar form. A specimen of the large *C. armata* from the Fiji Islands is exhibited.

Thalassina anomala is a widely distributed tropical species, especially characteristic of mangrove swamps, but sometimes found burrowing in damp earth at a considerable distance from the sea.

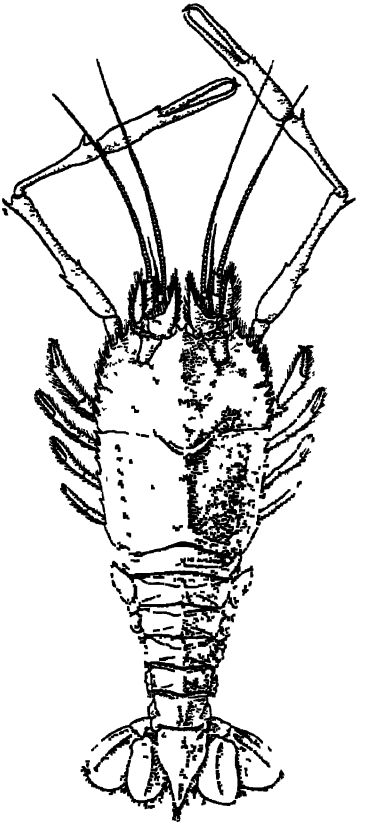


FIG. 38.

Polycheles phosphorus, female. (After Alcock.) [Table-case No. 11.]

SUB-ORDER 2.—ANOMURA.

The Anomura commonly have the abdomen more or less bent under the body, or else spirally coiled and asymmetrical. The Table-case No. 12.

Table-case No 12. front, or rostrum, is not united with the epistome The sixth pair of abdominal appendages (uropods) are rarely absent The last pair of legs are reduced in size and the last thoracic sternum is movable

The Sub-order is divided into three tribes, of which the first, PAGURIDEA, includes the Hermit-Crabs and their allies With few exceptions, the most important of which are the Coco-nut Crab, *Birgus*, and the family Lithodidae, the members of this tribe have the abdomen soft, not distinctly segmented, and spirally twisted in

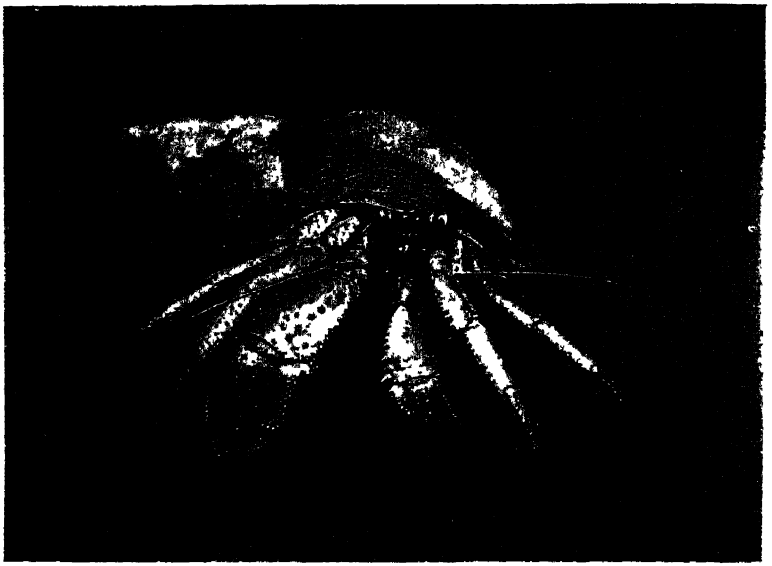


FIG. 39.

The common Hermit-Crab, *Eupagurus bernhardus*, in the shell of a whelk, reduced [Table-case No 12.]

adaptation to the habit of living in the empty shells of Gasteropod Molluscs.

The marine Hermit-crabs, forming the family *Paguridae*, nearly all live in shells, and very often the outside of the shell gives attachment to Sponges, Hydroid Zoophytes, or Sea Anemones, between which and the Hermit there may exist more or less definite relations of "commensalism." In the case of *Paguropsis typica*, here exhibited, no shell is carried, but the abdomen is protected by a cloak of living sea anemones held in position by the hinder legs of the crab. The commonest British species, *Eupagurus bernhardus* (Fig. 39), and one of the largest representatives

of the family, *Pagurus punctulatus*, are also placed in this case. Table-case No 12.

The members of the family *Coenobitidae* are Land-crabs, though their early stages are passed in the sea, and the adults visit the sea periodically. The species of *Coenobita* carry shells about with them like the marine Paguridae, but the "Robber-Crab" or

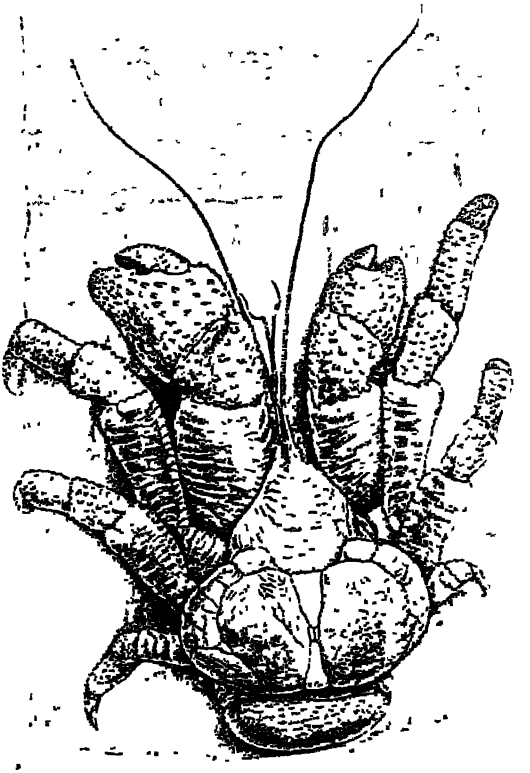


FIG. 40

The Coco-nut Crab, *Birgus latro*, much reduced [Wall-case No. 6.

"Coco-nut Crab," *Birgus latro* (Fig. 40), of which a specimen is shown in Wall-case No. 6, has given up the habit of carrying a portable dwelling, and the dorsal plates of the abdomen, which in the other hermit-crabs are soft and membranous, have again become hard and shelly.

The stories told of the tree-climbing habits of *Birgus* have often been doubted, but the matter is set at rest by a photograph exhibited in Wall-case No. 6. This photograph was taken on Christmas

Table-case No. 12. Island, in the Indian Ocean, by Dr. C. W. Andrews, F R S , of the Geological Department of the Museum, and it shows a specimen of *Birgus* in the act of descending the trunk of a sago-palm.

The members of the family *Lithodidae* have become completely crab-like in shape, and were formerly classified with the Brachyura, with which, however, they have no direct affinity. They may be at once distinguished from the true Crabs by having only three pairs of walking-legs visible behind the chelipeds, the last pair being carried folded up within the branchial chambers. Their relationship to the Hermit-Crabs is shown by the fact that the

FIG. 41.

The "Northern Stone-Crab," *Lithodes maia*, much reduced. The last pair of legs are folded out of sight in the gill chambers. [Table-case No. 12.]

abdomen is frequently asymmetrical, and has appendages only on one side. The last pair of abdominal appendages (uropods) are wanting.

The "Northern Stone Crab," *Lithodes maia* (Fig. 41), found on the more northerly coasts of the British Islands, belongs to this family. *Cryptolithodes* is an allied genus in which the carapace is expanded at the sides so as to cover the limbs completely. A specimen of the large *Echidnocerus cibarius* found on the West Coast of North America is placed in the lower part of Wall-case No. 2.

In the Tribe GALATHEIDEA the body is symmetrical, and more or less lobster-like, but the abdomen is bent upon itself, and sometimes folded under the body. The last pair of legs are slender and are carried folded up within the branchial chambers. The last pair of abdominal appendages (uropods) are large, forming a well-developed tail-fan. Table-case No. 12.

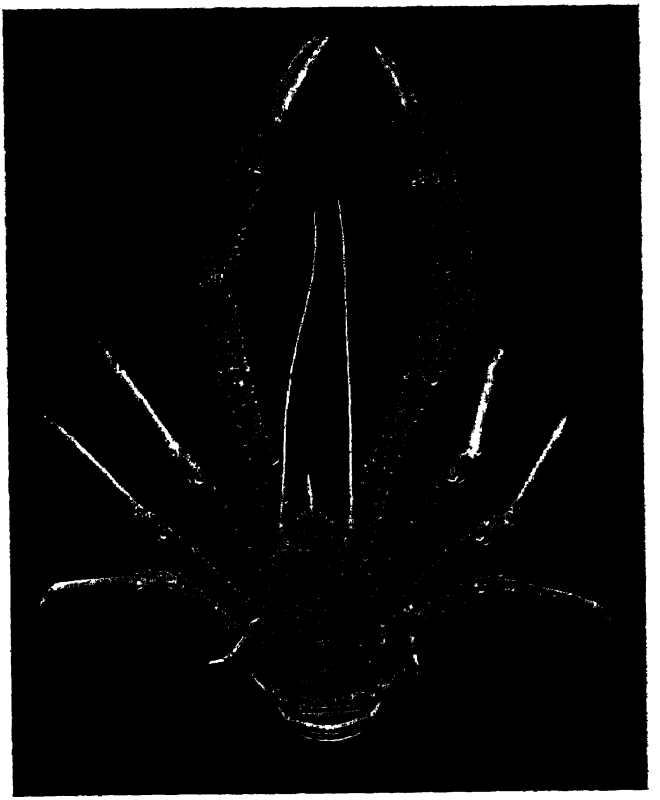


FIG. 42.

Munida rugosa (reduced) [Table-case No 12.]

Several species of *Galathea* occur on the British coasts, *G. strigosa* being the largest. *Munida rugosa* (Fig. 42) is found in rather deep water in British seas. The family *Uroptychidae* includes only deep-sea species and is represented by the brilliantly coloured *Eumunida picta*. The family *Aegleidae* comprises only a single species, *Aeglea laevis*, which is interesting as being the only Anomuran inhabiting fresh water. It is found in South America,

Table-case No 12

especially in mountain streams. In the family *Porcellanidae*, the short and broad carapace, without a prominent rostrum, and the fact that the abdomen is folded under the body, give the animals quite a crab-like appearance. They are, however, very closely allied to the Galatheidae. All the species are found in shallow water. The little "Porcelain Crabs" (*Porcellana*) of British coasts are represented in tropical seas by numerous species, some of which, like those exhibited, are of considerable size and striking colours

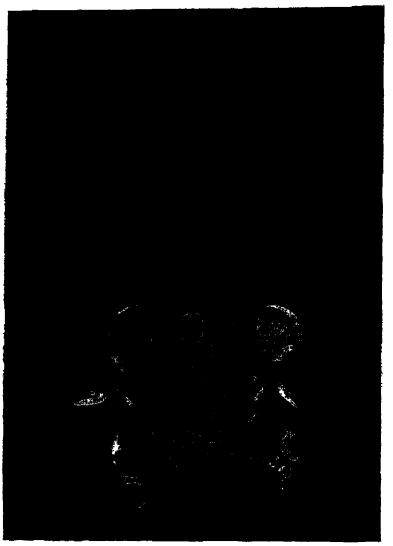


FIG 43.

Albunea symnista (reduced)
[Table-case No 12]

The small tribe HIPPIDEA includes small, crab-like, burrowing forms, living in sand and having the feet flattened for digging. They are only found in the warmer seas. In one of the families of this tribe, the *Albuneidae* (Fig. 43), when the animals are buried in sand, respiration is carried on by means of a tube formed by the long antennules, each of which bears a double row of stiff hairs. It is noteworthy that in the Brachyuran Corystidae (*see* Table-case No. 15), which have a very similar respiratory siphon, it is formed, not, as in this case, by the antennules, but by the antennae.

SUB-ORDER 3.—BRACHYURA.

Table-cases Nos. 12-16.

The BRACHYURA, or true Crabs, are distinguished from the other Decapoda by having the abdomen short and bent up under the body. The "front" sends down a process to meet the epistome, and thus forms a septum between the antennules The sixth pair of abdominal appendages (uropods) are generally absent, rarely present as rudiments. The third pair of maxillipeds are generally broad and flattened, forming a pair of "folding doors" which cover the other mouth-parts.

The Brachyura are usually divided into five Tribes, which, however, are not all of equal value :—

Tribe 1—Dromiacea. Tribe 3—Oxyrhyncha.
„ 2—Oxystomata. „ 4—Cyclometopa.
Tribe 5—Catometopa.

The DROMIACEA or Sponge-Crabs are the most primitive of the existing Brachyura. The last pair, or the last two pairs, of legs are dorsal in position, with hooked or prehensile claws, and are used for holding a piece of sponge, an Ascidian, or half of a bivalve shell, under which the animal is completely hidden. The mouth-frame is square. The primitive character of the group is shown especially by the retention of a vestigial pair of limbs on the first abdominal somite of the female, and often on the sixth abdominal Table-case No. 12.

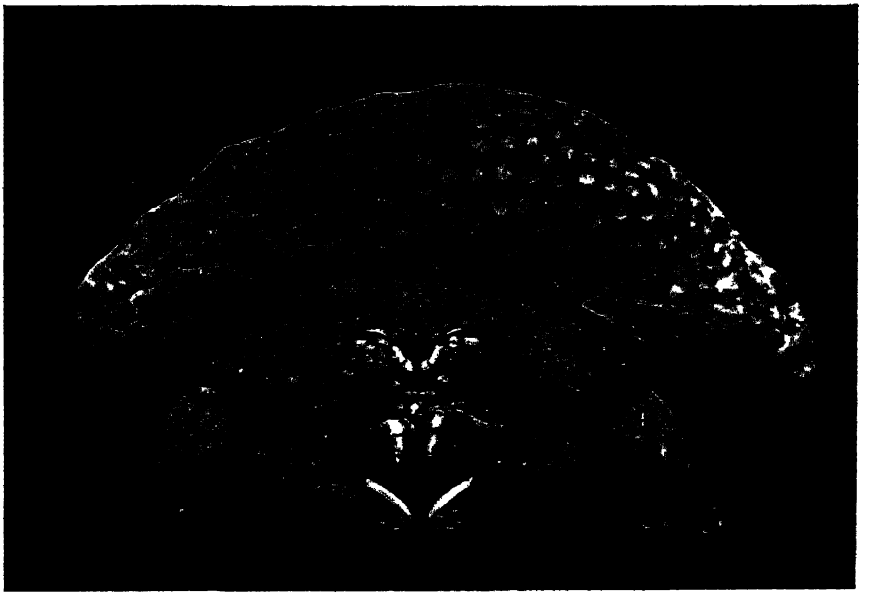


FIG. 44

Dromia vulgaris. Front view of a specimen carrying on its back a mass of the sponge *Cliona celata* (reduced). [Table-case No. 12.]

somite in both sexes (*see* the exhibited specimen of *Dromia lator*). The basal segment of the antenna is large and unusually free, the pits into which the antennules fold are not separated from the orbits, and the gills are, in most cases, more numerous than in the other Brachyura. The oviducts of the female open on the first segment of the third pair of legs.

Many of the Dromiacea, especially the more primitive forms, inhabit the deep sea. *Dromia vulgaris* (Fig. 44), which occurs off the South of England, belongs to the family *Dromiidae*, in which the last two pairs of legs are generally reduced in size, and are

Tab No.

Table-case No. 12.

elevated on the back. One of the specimens exhibited, taken in the Bristol Channel, carries as a cloak a specimen of the sponge *Cliona celata*. In the family *Dynomenidae*, represented by the little *Dynomene hispida*, only the last pair of legs are reduced and elevated on the back.

Latreillia elegans belongs to the aberrant family *Latreilliidae*. In the triangular shape of the carapace and the length and slenderness of the legs, the members of this family show a certain similarity to the Spider Crabs of the Tribe Oxyrhyncha.

To this group also belongs the family *Homolidae*, a typical example of which is the large *Homola* (*Paromola*) *cuvieri* (Fig. 45),

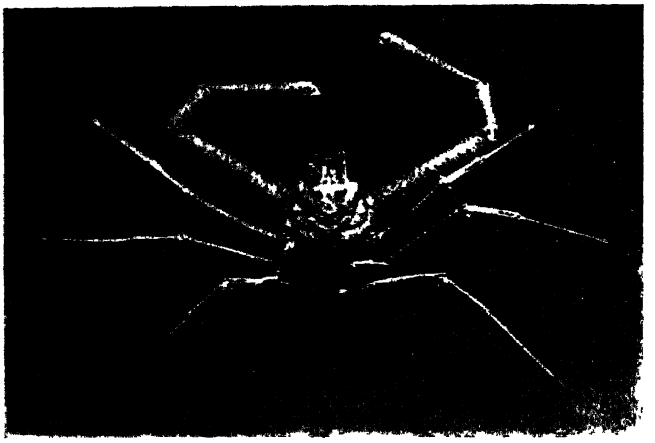


FIG 45

Homola cuvieri. The carapace of this specimen is about seven inches long [Wall-case No 5]

exhibited in Wall-case No. 5 This species has occurred, very rarely, on the west coasts of Ireland and Scotland.

The members of the family *Prosoponidae* are only known as fossils, but it has recently been shown that they are closely allied to the living *Dromiacea*, especially to the deep-sea *Homolodromiidae*. They range from the lower Oolite to the Upper Cretaceous. A cast of the carapace of *Prosopon mammillatum* illustrates this family.

Table-case No 13

The members of the tribe OXYSTOMATA, sometimes known as "Sand-Crabs," may be recognised by the triangular shape of the mouth-frame, which is narrowed in front and extends forward between the eyes. The channels which carry the outward stream

of water from the gills, and in most other crabs open at the front corners of the mouth-frame, are produced forwards to the front of the head and are closed in below by plate-like processes from the endopodites of the first maxillipeds. This arrangement is correlated with the characteristic habits of the tribe, nearly all the members of which conceal themselves in the sand, where they lie buried with only the eyes exposed. Table-case No. 13.

In the family *Calappidae* the openings by which the water enters the gill-chambers are situated, as in most Brachyura, in front of the bases of the chelipeds. The legs are normal in position.

A specimen of *Calappa hepatica* is exhibited which has been prepared to illustrate the distinctive characters of the tribe. The second and third maxillipeds have been removed on one side to show the triangular mouth-frame (coloured red) and the process from the endopodite (coloured blue) of the first maxilliped. The arrow indicates the course of the respiratory current. A broad space (marked X), free from hair, is seen on each side of the mouth-frame leading down to the entrance of the gill-chamber. When the chelipeds are closed up against the under surface of the body, as in one of the specimens of *Calappa flammea* exhibited, this space is converted into a tubular channel, through which a supply of pure water can reach the gills when the crab is buried in the sand.

The species of the genus *Matuta* swim well by means of their flattened, paddle-shaped feet, which are also used for digging in sand. The animals are said to bury themselves with wonderful rapidity. The channel leading to the entrance of the gill-chamber, seen in the preparation of *Calappa*, is here much deepened in its front portion, where the overarching hairs convert it into a tubular passage opening into the orbit.

In the family *Leucosiidae* the channels leading to the gills are completely covered in by the expanded exopodites of the third pair of maxillipeds. This character is illustrated by a preparation of *Parilia alcocki* (the largest species of the family), in which the second and third maxillipeds have been removed on one side. The mouth-frame is coloured red and the endopodite of the first maxilliped blue. X marks the inhalent respiratory channel. One of the third pair of maxillipeds is mounted separately to show the greatly expanded exopodite which, in the natural position, covers the inhalent channel.

The only Oxystomata found in British seas are several species

Table-case No 13. of the genus *Ebalia*. They are small Crabs, resembling the pebbles among which they are found. Specimens of *Ebalia tuberosa* are shown in their natural surroundings in Wall-case No 11

In the family *Dorippidae* the afferent branchial openings are in front of the bases of the chelipeds. The abdomen is not completely concealed under the cephalothorax. The last two pairs of legs are elevated on the dorsal surface of the body, and have the terminal segments more or less distinctly modified to form a prehensile claw. The Dorippidae appear to have given up the sand-burrowing habits characteristic of other Oxystomata, and they conceal themselves by holding a piece of sponge or some other object over the back by means of the hinder legs. Many of the species inhabit the deep sea.

In the *Raninidae* the water seems to enter the branchial chamber from behind, between the edge of the carapace and the bases of the last pair of legs. As in Dorippidae, some of the abdominal somites are visible from above, and the last pairs of legs are elevated on the dorsal surface. The legs, however, are flattened and paddle-like, and appear to be used for swimming and digging, as in *Matuta* The "frog-crab," *Ranina scabra*, is, in general appearance, one of the most striking and aberrant of the Brachyura.

Table-case No. 14. In the Tribe OXYRHYNCHA the carapace is usually triangular in shape, narrowed in front, and produced to form a rostrum. The mouth-frame is square. The genital ducts of the male open on the bases of the last pair of legs. As a rule, the legs are long and slender.

The Crabs of this tribe are generally sluggish and inactive animals, and many of them, as already mentioned, have the habit of masking themselves with seaweed, sponges, etc. This habit is illustrated by some of the preparations in Wall-case No. 6, and evidences of it will be noticed on many of the specimens in this case.

The members of the family *Maiidae* are known as "Spider-crabs." In these, the chelipeds are very mobile, and are usually not much stronger than the other legs. The orbits are more or less incomplete. Among the specimens exhibited may be mentioned *Macropodia longirostris*, a common British species which has the long and slender legs that are typical in the group. *Huenia proteus* is noteworthy for the leaf-like expansions of the carapace; in life it is of an olive-green colour and is difficult to detect among the foliaceous sea-weeds which it frequents. To this family belongs the large Spider-crab of the South and West

coasts of England, *Maia squinado*, a large specimen of which is exhibited in Wall-case No. 4. Table-case No 14.

Fig 46.

The Giant Japanese Crab, *Macrocheira kaempferi*, male The scale of the figure is given by a two-foot rule placed below the specimen. [Specimens of the male are mounted above Wall-cases 3 and 4, and one of the female above Wall-cases 1 and 2.]

Another noteworthy member of the family is the Giant Japanese Crab *Macrocheira* (or *Kaempferia*) *kaempferi* (Fig. 46), the largest of existing Arthropoda, of which two male specimens

Table-case No. 14.

and a female are mounted above the Wall-cases at the south end of the Gallery. They were coloured after a drawing of a live specimen by a Japanese artist.

In the family *Parthenopidae*, the chelipeds are usually much more massive than the other legs, and the orbits are well formed. The typical members of this family have taken to the same habitat as the Oxystomata, burying themselves in sand or shingle, and they show many superficial resemblances in the shape of the chelipeds, the lateral extensions of the carapace, and the disposition of the breathing channels, to such Oxystomes as *Calappa*. In many species, as in the *Parthenope horrida* exhibited, the carapace and limbs are remarkably rugged and uneven

Table-case No. 15

The Crabs belonging to the Tribe CYCLOMETOPA have the carapace, as a rule, broader than long, with the antero-lateral borders strongly curved, and the postero-lateral borders convergent; the front is not produced into a rostrum; the mouth-frame is square; the genital ducts of the male open on the bases of the last pair of legs With the exception of the River-crabs, all the members of this tribe inhabit the sea.

In the large and very varied family *Xanthidae*, the carapace, as a rule, is transversely oval, and its surface is often lobulated. The species of this family are very abundant, especially in the tropics, in the littoral region Three species of *Xantho* are British, one of which, *X. incisus*, is exhibited. The vivid colours of some tropical species are exemplified by the painted specimens of *Carpilius maculatus* and *Zozymus aeneus*. To this family also belongs the large Tasmanian Crab, *Pseudocarcinus gigas*, a specimen of which is mounted above Wall-cases Nos. 5 and 6

A specimen of *Zozymus aeneus* is exhibited which has been prepared to illustrate the disposition of the branchial passages in Cyclometopa, for comparison with similar preparations of the Oxystomata in Table-case No 13. The third maxilliped has been removed on one side to show the quadrilateral shape of the mouth-frame (coloured red), characteristic of most Brachyura. The arrow indicates the course of the respiratory current, which, however, may sometimes be temporarily reversed, especially in burrowing species

The typical members of the family *Portunidae* (Swimming Crabs) may be recognised by the flattened, paddle-shaped, last

pair of legs. Two British species of the genus *Portunus* are exhibited the colours of *P. depurator* have been carefully copied from a living individual, and the specimen is mounted on a sample of the shell-gravel on which it was actually caught. The large

Table case No. 15.

FIG 47.

Pseudocarcinus gigas, from Tasmania. The carapace of this specimen is just over a foot in width. [Above Wall-cases Nos. 5 and 6.]

Neptunus pelagicus is the commonest edible Crab in many parts of the East. The Common Shore-Crab, *Carcinus maenas*, is also referred to this family, although the paddle shape of the last legs is not so marked as in the more typical Portunidae.

Tal No. Table-case No. 15.

Podophthalmus vigil (Fig. 48) is remarkable for the great length of the eye-stalks, which is quite unusual among the Cyclometopa, and gives this Crab a curious likeness to the genus *Macrophthalmus* among the Ocypodidae (*see* Table-case No. 16) The resemblance, however, is quite superficial, for in this case it is the first of the two segments of the eye-stalk which is elongated, while in *Macrophthalmus* it is the second.

The genus *Platyonychus*, of which a group of specimens is mounted in Wall-case No. 5, also belongs to this family.

The *Cancridae* are distinguished from the preceding families by having the antennules folded longitudinally instead of transversely.

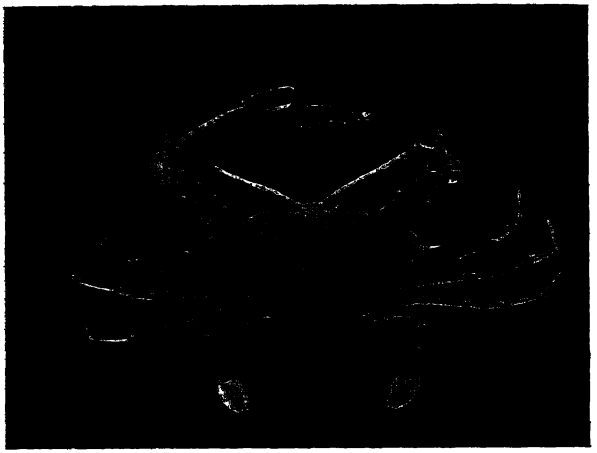


FIG. 48.

Podophthalmus vigil (reduced). [Table-case No. 15]

To the typical genus *Cancer* belongs the Edible Crab of British coasts, of which a large specimen is exhibited in Wall-case No. 5. The wide distribution of the genus is illustrated by species from the Azores and from New Zealand.

The family *Potamonidae* (*Thelphusidae*) comprises the River-Crabs. In the shape of the carapace, which is generally more or less square, and in having the front bent downwards, these Crabs show some resemblance to the next Tribe, Catometopa. They are widely distributed in fresh waters throughout the Tropics. *Potamon edule* (better known as *Thelphusa fluviatilis*) occurs in Italy and other parts of Southern Europe.

The family *Corystidae* includes Crabs which are allied to the Cancridae, but have long antennae, and the third maxillipeds are

elongated, extending over the front edge of the mouth-frame. The latter character recalls the Oxystomata, which the members of this family also resemble in their sand-burrowing habits. *Corystes cassivelaunus* (Fig. 49) is a common British species. The claws or chelipeds are much elongated in the male. The antennae are much longer than is usual in the Brachyura, and each bears a double row of bristles so arranged that when the antennae are brought together they form a tube, through which respiration can be carried on while the animal is buried in sand. Table-case No 15.

Female Male.

FIG 49.

Corystes cassivelaunus (slightly reduced). [Table-case No 15.]

In the tribe CATOMETOPA the carapace is typically more or less quadrate, with the front strongly bent downwards; the mouth-frame is square; the genital ducts of the male open on the sternum. A large proportion of the Crabs belonging to this tribe live on land, in fresh water, or between tide-marks on tropical shores. Only the chief families are illustrated in this Case Table-case No. 16.

The family *Geocarcinidae* (or *Gecarcinidae*) comprises the true Land-Crabs, although some members of the other families also

Table-case No. 16.

are almost entirely terrestrial in habits The carapace is more or less transversely oval, and the front is of moderate breadth. The branchial regions of the carapace are generally swollen, and the lining membrane of the gill-chamber is richly supplied with blood-vessels, and acts as a lung Typical genera are *Geocarcinus*, *Cardisoma*, and *Uca*

The Crabs of the family *Grapsidae* are the most typical Catometopa. The carapace is nearly quadrilateral, with the front very broad, and the orbits near the antero-lateral corners Many species are estuarine or fluviatile in habitat The species of *Grapsus* and allied genera are common shore Crabs in all the warmer seas.

The genus *Sesarma* and its allies include, for the most part, amphibious fresh-water Crabs, abundant in the tropical regions of the Old and New Worlds

Varuna litterata is widely distributed throughout the Indo-Pacific region, and seems to be equally at home in fresh water and in the sea. It is often found clinging to drift-wood at the surface of the sea

The little *Planes minutus* also lives at the surface of the open sea, clinging to floating weed or drift-wood, or to the bodies of large marine animals such as turtles It is especially abundant in the Sargasso Sea, but is widely distributed in the warmer regions of all the oceans, and is occasionally carried to the South and West coasts of the British Islands. It is related of this species that "Columbus, finding this alive on the Sargasso floating in the sea, conceived himself not far from some land, on the first voyage he made on the discovery of the West Indies" (Sloane, Nat Hist Jamaica, II. p. 2).

In the family *Ocypodidae* the front is generally narrow and the eye-stalks are often very long. Most of the species are amphibious shore Crabs, burrowing and often gregarious in their habits. Several species of the typical genus *Ocypoda* are exhibited.

The species of *Gelasimus*, often called "Fiddler Crabs" or "Calling Crabs," are common on most tropical shores, living in vast numbers in salt marshes or between tide-marks, where they make burrows in the sand or mud. A group of specimens of two species is mounted in Wall-case No. 5. The genus is of interest as exhibiting in an extreme degree two characters which are more or less marked in nearly all Crabs—the unequal development of the chelae or pincers on the two sides of the body, and their greater size in the male sex. The large, brightly coloured claws

are used by the males in fighting with each other, and are also believed to serve to attract the females Table-case No. 16.

Gelasimus tangeri occurs on the Spanish coast near Cadiz, where there is a regular "fishery" for these Crabs Only the large claws of the males are taken, and are prepared for the market by cooking and then drying. After the claw has been torn away, the Crab grows a new one in its place, but these regenerated claws are smaller, and are regarded as of inferior quality.

FIG 50

Gelasimus tangeri, male (below) and female (above). Table-case No 16.

The genus *Macrophthalmus* (Fig. 51) has already been mentioned (p. 72) as having a superficial resemblance to the Portunid *Podophthalmus*

The members of the family *Pinnotheridae* are small parasitic or commensal Crabs, living in the mantle-cavity of bivalve Mollusca, in Ascidians or Echinoderms, or in coral-stocks. The shell is usually soft, and the eyes, antennules, and antennae much reduced. A preparation is exhibited of a Sea-Urchin, *Strongylocentrotus gibbosus*, found on the coast of Chile. One half of the shell has been cut away to show the Crab *Pinnaxodes chilensis* lying in a

Tal
No.

Table-case No. 16.

large pouch which is formed by enlargement of the terminal part of the Sea-Urchin's intestine.

The family *Gonoplacidae* includes Crabs that in many respects approach the tribe Cyclometopa. The only British species is *Gonoplax rhomboides*.

The small Crabs included in the family *Hymenosomidae* have

FIG. 51.

Macrophthalmus pectinipes, reduced. [Table-case No. 16.]

a more or less triangular front, and in other respects show some resemblance to the Oxyrhyncha. *Halicarcinus planatus*, of which specimens obtained by the "Discovery" Expedition at the Auckland Islands are exhibited, is found throughout the whole of the "Sub-Antarctic" region, occurring at such distant points as the Falkland Islands, the Cape, Kerguelen Island, and New Zealand.

Class 2.—TRILOBITA.

The members of this class are known only in the fossil state, and are characteristic of the strata of the Palæozoic era. They are especially abundant in the Silurian and pre-Silurian rocks. On the whole, they seem to be most closely related to the Arachnida, and especially to the Xiphosura or King-crabs, but in certain features they resemble the *Crustacea*, and some authorities are of opinion that they are allied to that class. The somites of Table-case No 17.

FIG. 52.

Reconstruction of a Trilobite, *Triarthrus becki*.
Natural size (after Beecher)

the body are variable in number, each, so far as is known, being provided with a pair of appendages which, with the exception of the pre-oral pair, are substantially similar in structure and function.

The dorsal plates of the five somites composing the anterior region of the animal (the "head" or prosoma) are fused to form a carapace or "cephalic shield"; its median area is vaulted, and each of the lateral areas is expanded, laminate, and divided by a groove into an inner and an outer portion; upon the latter a large compound eye is present.

The somites of the middle portion of the body (thorax or

Table-case No. 17.

mesosoma), which vary in number from two to as many as twenty-nine, were movably jointed together in the living animal. Each consists of a vaulted dorsal area (the tergum), and a flat membranous ventral area (the sternum), and, on each side, a laminate expansion overlapping the greater part or the whole of the legs. The convexity of the terga and of the upper surface of the lateral laminae gives to the body a three-lobed appearance, from which the name Trilobita is derived. The dorsal and lateral plates of the somites of the posterior region of the body (pygidium or metasoma) are immovably united, although generally defined by transverse grooves.

The appendages of the first pair, where known, are each in the form of a single long, branched, antenniform limb. Those of the

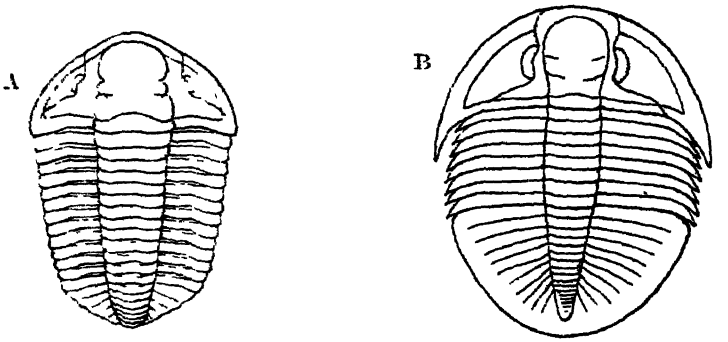


FIG. 53.

Examples of Trilobites. A—*Calymene blumenbachii* (Upper Silurian) B—*Ogygia buchii* (Ordovician).

remaining pairs consist of two branches rising from a common basal segment. The external branch is slender, many-jointed, and furnished with a series of slender branchial filaments; the internal branch, constituting the locomotor portion of the limb, consists of six or, including the basal segment, seven segments. The post-oral appendages of the prosoma resemble those of the rest of the body, except that the inner extremities of the basal segments are toothed to act as jaws.

The Trilobites are an extinct group of marine Arthropoda which probably resembled the existing King-crabs in habits, and crept about the bottom of the sea, feeding upon worms and other soft animal organisms, which were crushed between the basal segments of the anterior appendages. On account of the softness and membranous nature of the sternal region they were able to double

up the body or roll it up in a sphere, like wood-lice (as shown by two of the specimens of *Calymene blumenbachii* in Table-case 17); and this habit, coupled with the strong spines with which the dorsal area was frequently armed, suggests that the Trilobites themselves were in need of protection from more powerful inhabitants of the seas Table-case No. 17.

About 2,000 species have been described from Cambrian and later beds of the Palæozoic period, at the close of which the group became extinct.

A restoration and drawings of *Triarthrus becki* and a few specimens and casts of other Trilobites are exhibited in Table-case 17. The attention of those who are interested in these Arthropods is directed to the account of them which appears in the "Guide to the Fossil Invertebrate Animals," and to the series of specimens displayed in the Geological Department (Gallery 8, Table-case 25, Wall-case 14 b).

Class 3.—ARACHNIDA.

Table-cases Nos 19-26

The Arachnida, a class which includes such familiar animals as the spiders, scorpions, and mites, constitutes one of the main divisions of the Phylum Arthropoda. The earlier members of the class led an aquatic life, and the middle region of the body, in these forms, was furnished with large plate-like respiratory appendages, suitable for breathing oxygen dissolved in water. The King-crabs are the only surviving representatives of these branchiferous forms. The rest of the living Arachnids are almost invariably terrestrial forms, and the respiratory lamellae have either sunk below the surface of the body, and become adapted to breathe atmospheric oxygen, or have been entirely replaced by tracheal tubes.

In the more primitive forms three principal divisions of the body can be distinguished. The dorsal plates of the first of these (prosoma or "cephalothorax") are fused to form a carapace, and its appendages are six in number. The middle region of the body (mesosoma) is nearly always fused with the posterior region (metasoma), to form a single division (the opisthosoma or "abdomen"). The mesosomatic appendages may number six, but are often suppressed or reduced in number. In its primitive form the metasoma consists of six distinct limbless somites and a post-anal spine or sting.

The class is composed of two divisions: 1. The Euarachnida or Arachnida proper, which includes the Scorpions, Spiders, Mites, etc., and also the King-crabs and the extinct forms known as Eurypterines. 2. The Pycnogonida, or Pantopoda, a marine group of doubtful affinities.

Table of Classification of the Arachnida.

Class—ARACHNIDA.

Sub-class 1.—EUARACHNIDA.

Division A.—Delobranchia.

Order 1.—*Xiphosura* (King-crabs).

„ 2.—*Gigantostraca* (Eurypterines—Fossil forms).

Division B.—EMBOLOBRANCHIA.
Order 1.—*Scorpiones* (Scorpions).
,, 2.—*Pedipalpi* (Whip-scorpions and their allies).
,, 3.—*Palpigradi.*
,, 4.—*Araneae* (Spiders).
,, 5.—*Solifugae* (False Spiders).
,, 6.—*Pseudoscorpiones* (False Scorpions).
,, 7.—*Podogona.*
,, 8.—*Opiliones* (Harvest-men).
,, 9.—*Acari* (Mites).
Sub-class 2.—PYCNOGONIDA.

Sub-class 1.—EUARACHNIDA.

Both the prosoma ("cephalothorax") and the opisthosoma ("abdomen") are well developed in these Arachnida and are typically separated from one another by a praegenital segment, which generally disappears, however, in the adult. The prosoma is usually covered dorsally by an undivided carapace which is, however, sometimes segmented posteriorly. Its appendages number six pairs. The first pair ("chelicerae") are often chelate or prehensile, whilst the second, third, and fourth pairs may also be chelate, but are usually feelers (palps) or walking legs. When fully developed, the mesosoma consists of six somites, which bear plate-like appendages in the aquatic species, in the land forms these appendages are much reduced and modified or absent The metasoma also typically consists of six somites, which are devoid of appendages. The mesosoma and metasoma are often fused to form an opisthosoma or "abdomen," and obliteration of segmentation often takes place.

The Euarachnida are divided into two Grades —

DIVISION A.—*DELOBRANCHIA.*

The respiratory organs of the Delobranchia are of an aquatic type, all the large plate-like appendages of the middle region of the body (mesosoma), with the exception of the first, being furnished with branchial lamellæ. There are two orders.

Order 1.—Xiphosura (King-crabs).

None of the appendages of the prosoma are paddle-like in form in the Xiphosura. The segments of the opisthosoma do not

Table-case No. 18. Wall-case No. 7

exceed ten in number. The American King-crab (*Xiphosura polyphemus*) differs from the Oriental species in having the terminal segment of the inner branch of the genital operculum (on each side) retained as a free movable lobe, whilst in the Oriental genera (*Tachypleus* and *Carcinoscorpius*) it is suppressed. The three genera which have resulted from the subdivision of the old genus *Limulus* are referable to a single family, *Xiphosuridae*.

The King-crabs are marine, shore-frequenting forms. They live in water of moderate depth, burrowing in the sand at the bottom, and their food consists of bivalves, worms, etc. They occur on the Eastern coast of North and Central America, and in the

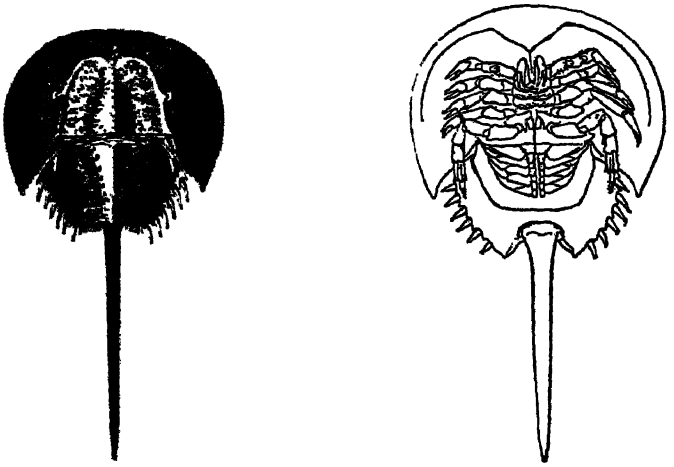


FIG. 54.

The American King-crab (*Xiphosura polyphemus*). About $\frac{1}{11}$ the diameter of the animal.

Oriental seas from the Bay of Bengal to the coasts of China and Japan, Torres Straits, etc. A number of small Palaeozoic forms (e.g. *Belinurus* and *Hemiaspis*, of which figures are shown in Table-case 18) are known, which seem to be intermediate in structure between the Xiphosura and the Trilobites. Forms which resemble the modern type of Xiphosura first appear in the Triassic rocks. Several specimens of King-crabs from the Solenhofen stone (Jurassic Period) are shown in the Geological Department. (Gallery 8, Wall-case 13c.)

A large example of a King-crab (*Tachypleus tridentatus*) from British North Borneo is displayed in the upper part of Wall-case 7, and representatives of the three genera are shown in Table-case 18.

Order 2.—Gigantostraca (Eurypterines).

In the Gigantostraca the sixth (or fifth and sixth) pairs of the appendages of the prosoma are modified to act as paddles. There are twelve distinct somites in the hinder region of the body (mesosoma and metasoma).

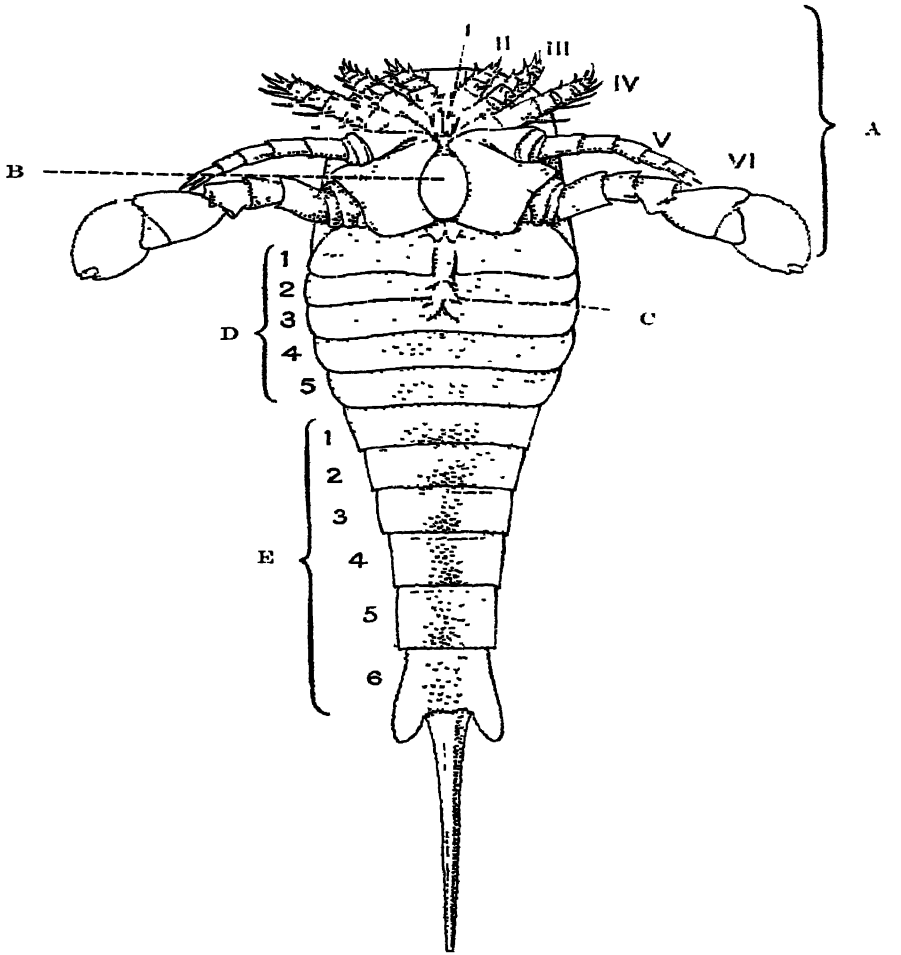


FIG. 55.

Restoration of *Eurypterus fischeri* (after Holm). A—Appendages of prosoma. B—Sternal plate of prosoma. C—Appendage believed to distinguish the female sex, perhaps an ovipositor. D.—Plate-like appendages of mesosoma. The first plate (which corresponds to two somites of the body) is the genital operculum. E—Sternal plates of metasoma.

Table-case No 19

The members of this order became extinct in Palaeozoic times. They have been found chiefly in the Upper Silurian, but are known to extend upwards as far as the Carboniferous. They were free-swimming forms, probably marine.

A model of one of the Gigantostraca (*Eurypterus fischeri*) is exhibited between Table-cases 16 and 17, in the Insect gallery. The fossils from which this model has been reconstructed are found in limestone of Upper Silurian age on the island of Oesel in the Baltic, and are remarkable from the fact that the chitinous substance of the outer coat of the animal has been preserved unaltered in chemical and physical composition. It has been possible to dissolve the remains out from the rock and to mount them as microscopic preparations. As a result, it can now be said that the structure of this species is better known than that of any other extinct Arthropod. Specimens and drawings further illustrating the group are exhibited in Table-case 19. Reference must be also made to the large specimens of *Pterygotus* and to the model of *Slimonia*, which are placed on the wall (between Cases 12 and 13, and 13 and 14) in the Geological Department.

Division B—*EMBOLOBRANCHIA*

The grade Embolobranchia contains the air-breathing forms of Arachnida, in which respiration is carried on by internal pulmonary sacs or tracheal tubes. There are nine orders

Order 1.—Scorpiones (Scorpions).

Table-cases Nos 19, 20.

The members of this order are remarkably uniform in structure. The prosoma ("cephalothorax") is covered by an unsegmented carapace, which bears from two to five lateral eyes, besides the paired median eyes. The first two pairs of appendages are in the form of pincers, the first pair or chelicerae being small and three-jointed, whilst the second, or palps, are very large and have six joints. All four pairs of legs are of the walking type and are furnished with paired movable claws. The mesosoma, like the metasoma, consists of six distinct somites, and the five posterior of the latter region are narrowed to form the tail, which also includes the post-anal sting. A pair of curious comb-like organs, the pectines, tactile in function, are present on the lower surface of the second mesosomatic somite. The respiratory organs consist of four pairs of lung-books, the cavities of which

are filled up with lamellae, which are arranged like the leaves of a book. Table-cases Nos 19, 20

A number of species possess sound-making organs, which are usually situated between the chelicerae or between the palp and the first leg.

The scorpions are a very ancient group Fossil species which closely resemble the living forms have been found in strata of the Silurian age. They differ from the Carboniferous and recent species chiefly in that the terminal segments of the legs are thicker, and that the tips of the legs are bluntly pointed and without movable claws.

In the Geological Department, specimens of the Carboniferous scorpions (*Eoscorpius* and *Cyclophthalmus*) are exhibited in Gallery 8, Table-case 23, and Wall-case 13c.

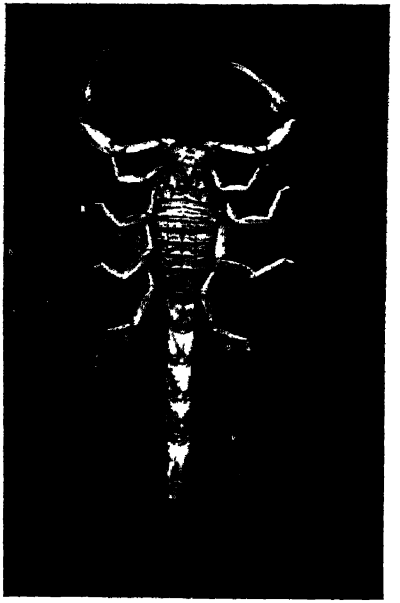


FIG. 56

Buthus occitanus (slightly reduced)

At the present time scorpions are found in all the warmer regions of the world Several of the West African and Indian species (*Pandinus* and *Palamnaeus*) are of very large size, one or two of them reaching a length of about nine inches. There are several European species, the largest of them belonging to the genus *Buthus*, which has two representatives in Europe. One of these (*Buthus occitanus*) is common in the South of Europe and also occurs in the North of Africa, and the other is found in Greece Another member of the Buthidae (*Butheolus melanurus*), which is of small size, lives in Sicily. The little black scorpions of the genus *Euscorpius* are abundant in the south of Europe. They live under stones and in other obscure situations, and sometimes make their way into houses in the wet weather; there are four European species. An allied genus (*Belisarius*), with a single species, which has lost all trace of eyes, is restricted in distribution to the Eastern Pyrenees. One of the Buthidae (*Isometrus maculatus*)

Table-cases Nos. 19, 20.

has been introduced into all the warmer regions of the world, and is found in oceanic islands.

Scorpions are carnivorous, feeding chiefly on insects. As is well-known, they are poisonous; the poison glands, which are paired, are situated in the terminal bulb of the tail. The larger species mostly construct deep burrows with their pincers, others live in shallow excavations under stones or under the bark of fallen trees

A representation of the burrows of the common Egyptian scorpion (*Buthus quinquestriatus*) is placed in Wall-case 7.

The young of scorpions are born fully formed, but in some species at least they are still enclosed within the egg-shell at birth and are liberated by their mother or by their own efforts. Until they are able to shift for themselves they are carried about on the back of the mother; a female example of a South American scorpion (*Centrurus margaritatus*), carrying its family on its back, is exhibited in Table-case 19.

The classification of the scorpions is still in an unsettled state; the recent species are arranged by Mr. Pocock in four families: 1. PANDINIDAE. 2. BOTHRIURIDAE. 3. VEJOVIDAE. 4. BUTHIDAE.

A representative series of scorpions is displayed in Table-case 20.

FAM 1.—*Pandinidae.*

This family, which contains the largest of the existing scorpions, is found in Africa, South Asia, Australia, and South America. It is characterised by having the sternum of the cephalothorax pentagonal in shape, and by the presence of only a single pedal spur upon the feet. (Genera: *Pandinus*, *Opisthophthalmus*, *Urodacus*, etc.)

FAM. 2.—*Bothriuridae.*

This family is confined to South America and Australia. It is characterised by having the sternum strongly compressed antero-posteriorly, and reduced to a short but wide transversely-lying plate. There are two pedal spurs on the feet. (Genera: *Bothriurus*, *Cercophonius*, etc.).

FAM. 3.—*Vejovidae.*

The representatives of this family are found in South Europe, Asia, and North and South America, but are entirely unknown in

tropical Africa, Madagascar, and Australia. The sternum is pentagonal, as in the Pandinidae, but is variable in form, being sometimes much wider than long, sometimes as long as wide. The presence of two pedal spurs upon the feet furnishes the best character for distinguishing the Vejovidae from the Pandinidae. (Genera: *Vejovis*, *Iurus*, *Euscorpius*, *Broteas*, etc.). Table-cases Nos. 19, 20.

FAM. 4.—*Buthidae.*

The Buthidae, which are universally distributed to the South of about the 45th parallel of North latitude, are distinguished from the Vejovidae by the triangular shape of the sternum and by the bifurcation of the anterior pedal spur. (Genera: *Buthus*, *Centrurus*, *Isometrus*, etc.)

Order 2.—Pedipalpi (Whip-scorpions and their allies).

The cephalothorax (prosoma) in these Arachnida is covered dorsally by a carapace, which is sometimes segmented posteriorly. A deep constriction separates this region of the body from the abdomen (opisthosoma), which has eleven somites. The palps are of large size and are chelate or sub-chelate in form The third appendage (first leg) is longer and more slender than the remaining legs, and has the terminal segment (or segments) sub-divided; it is used as a feeler There are no poison-glands in these animals Table-case No. 21.

These Arachnids are inhabitants of the warmer parts of the globe They are found in damp places under stones or fallen leaves, in the crevices of rocks, and in other similar places. Several fossil species have been discovered in the Carboniferous strata The Pedipalpi are divided into two sub-orders.

SUB-ORDER I.—UROPYGI.

In these Pedipalpi the cephalothorax is longer than wide. The tarsi of the third pair of appendages are divided into eight or nine segments. There are two tribes.

TRIBE—*UROTRICHA.*

Uropygi in which the carapace is unsegmented and bears well-developed eyes.

On account of their long and many-jointed tail and of their

Table-case No 21. superficial resemblance to scorpions, the Urotricha are known as Whip-scorpions. All the known genera (which number ten) are referred to the family *Thelyphonidae*, which is now restricted

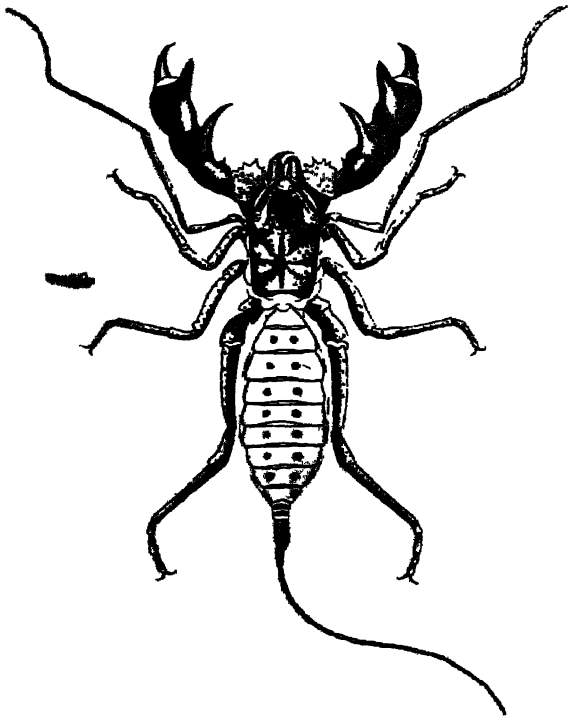


FIG. 57.
Whip-scorpion (*Thelyphonus caudatus*), × 2

to South-Eastern Asia and Tropical America. Of the genera, *Thelyphonus*, which is widely distributed in the Oriental region, is the richest in species. The largest known species of Thelyphonid (*Mastigoproctus giganteus*), a species which is found in the southern part of North America, sometimes reaches a length of more than two and a half inches. In the Carboniferous period the family was represented by the genus *Geralinura*, which has been discovered both in Europe and in North America.

Whip-scorpions live beneath stones or fallen tree-trunks, or in burrows in the soil. They feed mostly on insects, which they

crush with their powerful pincers. When irritated they eject an offensive acid secretion, which is the product of two large glands opening on the end of the last abdominal segment. The female, after laying her eggs, carries them about attached to the under side of her body. Table-case No. 21.

TRIBE—*TARTARIDES.*

The carapace of the cephalothorax is segmented posteriorly; it sometimes bears a pair of lateral eye-specks, but these are often obsolete or absent. The tail is short and is unsegmented in the male sex, whilst in the female it has three or four joints

The Pedipalpi belonging to this tribe, which contains the single family *Schizomidae*, are small in size and show traces of degeneration. They live under stones and vegetation in the tropical parts of Africa, Asia and America. Two genera (*Schizomus* and *Trithyreus*) are known

Drawings of a Tartarid (*Schizomus crassicaudus*), to illustrate the morphology of the group, are placed in Table-case 21.

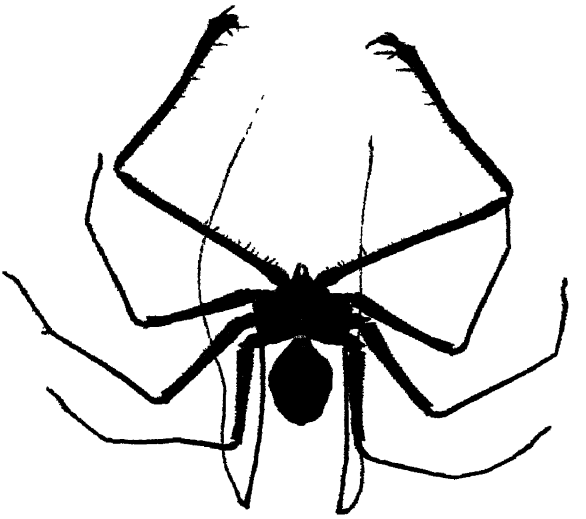


FIG 58

Damon johnstoni (one-half natural size).

SUB-ORDER II
AMBLYPYGI

The cephalothorax of these Pedipalpi is wider than long. All the segments of the legs of the first pair, with the exception of the basal three, are sub-divided so as to form a long flagellum.

Table-case No. 21.

The Amblypygi were represented in the Carboniferous period by the genus *Graeophonus*. At the present time they are confined to the warmer parts of Africa, Asia and America, the largest species, which belong to the genera *Damon* and *Heterophrynus*, being met with in the tropical forests of West Africa and Brazil By the flatness of the body and by the lateral projection of the legs, they are admirably fitted for living under stones and the loosened bark of fallen trees or in the crevices of rocks. The Amblypygi of the section *Charontinae* live in caverns. The feeding and breeding habits of the Pedipalps of this sub-order are similar to those of the Whip-scorpions.

There is a single family *Tarantulidae*, with ten genera, none of which are very numerous in species.

Order 3.—Palpigradi.

A carapace, which is divided into three segments (the large anterior one of which represents the terga of the first four somites), covers the cephalothorax (prosoma) in the Palpigradi. The appendages of the first pair are large, chelate and three-jointed; those of the second slender, like the remaining pairs, and armed with three claws. A narrow waist separates the cephalothorax and abdomen (opisthosoma) from one another. There are ten abdominal somites, which are not divided into dorsal and ventral plates, and the last three of them are narrowed to form a flexible support for the long many-jointed post-anal flagellum. Respiratory organs are absent.

Fig. 59.

Koenenia mirabilis (magnified).

These interesting Arachnids were first discovered by Professor Grassi, who described and figured an Italian species in the year 1885. They are minute creatures, usually measuring less than two millimetres, or barely one-twelfth of an inch in length. All the known species belong to the genus *Koenenia*, which has been discovered in South Europe, Tunis, Siam, Texas, Chile and Paraguay. They are blind, practically colourless animals, living in damp earth or under moist leaves, under stones, or in caves.

Several drawings of *Koenenia mirabilis* are on view in Table-case 21.

Order 4.—Araneae (Spiders).

The carapace of the cephalothorax (prosoma) is unsegmented in the spiders, and the eyes are situated in the middle of its anterior margin; they are usually eight in number, and are typically arranged in two transverse rows, but there are many other arrangements in the various families. The first appendages or chelicerae consist of two segments, the basal one of which contains the poison-gland, whilst the apical one forms a retroverted fang. All the remaining appendages are leg-like in form; in the male a complicated copulatory organ is present on the lower side of the terminal segment of the second appendage or palp. A narrow pedicel separates the cephalothorax from the "abdomen" (opisthosoma); with very few exceptions the latter is unsegmented, and its lower surface is always furnished with a number of spinning appendages. Two pairs of lung-sacs may be present, but the posterior pair of these is replaced by tracheal tubes in most spiders, and in a few species this is also the case with the anterior pair. Table-cases Nos. 22, 23.

Sound-producing organs, which are sometimes very complex in structure, occur in a large number of Mygalomorph spiders. They usually consist of arrangements of spines and rods which are situated on the opposed surfaces of the basal joints of the anterior limbs (either between the two chelicerae, or between the chelicerae and the palps, or between the palps and the legs of the first pair). The presence of a stridulatory organ in these bird-eating spiders was first made known by Professor Wood-Mason in an Assamese species (*Chilobrachys stridulans*). In this spider the inner surface of the basal segment of the palp is furnished with a row of vibratile bacilliform bristles and the opposed surface of the chelicera with a number of strong spines. When irritated the spider assumes a threatening attitude, raising itself upon its hind legs and brandishing the front legs in the air, at the same time making an audible rasping noise by rubbing together the basal segments of the two anterior appendages.

Another very similar type of stridulatory apparatus is present in a number of the Arachnomorph spiders of the family *Sicariidae* (in the genera *Sicarius* and *Scytodes*). The inner surface of the femur of the palp in these spiders bears a single tubercle (or a longitudinal row of tubercles), whilst the outer surface of the chelicera is provided with a series of well-marked transverse ridges. The noise made by the spiders of this family has been compared to the buzzing of a bee.

Table-cases Nos. 22, 23.

Mention must also be made here of the curious sound-producing organs which are found in many of the *Theridiidae*. These spiders have the anterior part of the abdomen especially hollowed out and hardened, the surface of this concavity being armed with teeth or ridges which can be moved against the granular or striated surface of the posterior end of the cephalothorax. In several of the *Agelenidae* also an analogous structure occurs, but the structures on the abdomen are rubbed against an enlarged tooth-like projection, which is present on the pedicel separating the cephalothorax from the abdomen.

Spiders are oviparous. They construct a "cocoon" (or several cocoons) for the protection of the eggs, and this usually consists of several layers of silk, the outermost coat in many cases being of especial strength or thickness. Many species seem to give but little or no attention to their cocoon when once it has been completed. Very often, however, the mother watches over it with extreme solicitude until the young spiders emerge, and displays great courage in its defence in times of danger. Special tents or cells of silk for the reception of the cocoon are constructed by many of the spiders which lead a wandering life, and by the tube-spinning spiders (*see* Wall-case 7). In these cases the mother shuts herself up with the cocoon, remaining within on guard until the eggs hatch. A large number of spiders which lead a predatory life (*Lycosidae*, etc.) carry the cocoon about with them, either in their chelicerae or attached to their spinnerets.

The dispersal of the young of Araneids, which usually takes place during the early part of the summer or in the autumn in this country, is greatly helped by their aeronautic habits. The young spider climbs to the top of a shrub or other point of vantage and turns its face in the direction from which the wind is blowing It then proceeds to straighten its legs, standing on the tips of them and elevating its abdomen in the air. One or more threads of silk now make their appearance, issuing from the spinnerets, and are drawn out by the wind into long floating lines. At length the spider lets go and is wafted away through the air, supported by its air-ship of threads. In his "Naturalist's Voyage" Darwin makes the following interesting observation on the ballooning habit of spiders: "On several occasions, when the *Beagle* has been within the mouth of the Plata, the rigging has been coated with the web of the Gossamer Spider. One day (November 1st, 1832) I paid particular attention to this subject. The weather had been fine and clear, and in the morning the air was full of patches of

flocculent web, as on an autumnal day in England. The ship was sixty miles distant from the land, in the direction of a steady though light breeze. Vast numbers of a small spider, about one-tenth of an inch in length, and of a dusky red colour, were attached to the webs. There must have been, I should suppose, some thousands on the ship The little spider, when first coming in contact with the rigging, was always seated on a single thread, and not on the flocculent mass. This latter seems merely to be produced by the entanglement of the single threads. . ." Table-cases Nos. 22 23

Spiders are divided into two sub-orders 1. MESOTHELAE. 2. OPISTHOTHELAE

SUB-ORDER I.—MESOTHELAE

In the Mesothelae the spinning appendages consist of two pairs of biramous limbs, which are situated far in advance of the anus, immediately behind the pulmonary sacs. The abdomen is distinctly segmented, the upper surface being furnished with a series of eleven tergal plates, and its ventral surface with two large plates overlying the pulmonary sacs, and a number of small plates behind the spinnerets. Table-case No. 22.

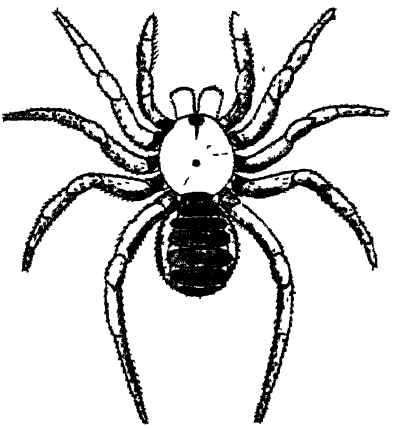


FIG 60.
Liphistius desultor

In the segmentation of the body and in the position of their spinnerets, the Mesothelae differ from all other living spiders, and resemble certain extinct (Carboniferous) types (*Protolycosa*, etc.). There is but a single family with two genera (*Liphistius* and *Anadiastothele*), which occur in Burma, Malacca, and Sumatra Specimens have been captured in the depths of limestone caverns in Malacca, and it is possible that the apparent rarity of these spiders is due to their restriction to a cave habitat. A specimen of *Liphistius desultor* is exhibited in Table-case 22.

Sub-order II.—OPISTHOTHELAE.

Table-case No. 22.

The spinning appendages in the members of this sub-order are situated at the posterior end of the abdomen, just in front of the anus. All trace of the tergal plates of the abdomen has been lost, and remnants only of the ventral plates are to be found protecting the pulmonary sacs.

To the Opisthothelae belong all existing spiders (with the exception of *Liphistius* and *Anadiastothele*), and the majority of those found fossilised in the gypsum or amber-beds and lacustrine deposits of the Miocene and Oligocene periods in Europe and North America.

Tribe I.—Mygalomorphae.

In the spiders belonging to this group the posterior pair of biramous spinning appendages are usually alone retained. The basal segment of the first appendage projects forwards, the fang closing backwards upon it. Two pairs of pulmonary sacs are present.

This group contains the bird-eating spiders ("*Mygale*") and trap-door spiders and their allies, which are nearly all confined to the tropical or warmer temperate regions. There are a number of families, the more interesting of which are briefly described below.

Fam.—*Aviculariidae.*

The spiders of this family have the tips of the legs and the under surface of the terminal joint (or joints) of the legs furnished with a dense pad of iridescent hairs. Digging spines are not present on the chelicerae.

The large, hairy spiders, which are commonly known as "*Mygale*," or bird-eating spiders, belong to this family. A West Indian species (*Psalmopoeus cambridgi*) is sometimes found concealed in the bunches of bananas which are imported into this country. Some of the South American species (*Theraphosa*, *Xenesthis*) reach a very large size, and are the largest known spiders. They are nearly all tropical forms. So far as is known, none of them spin regular snares; many of them, however, construct a silken funnel at the entrance to their nests. In an allied family, the *Dipluridae*, the entrance is surrounded by a large flat web, which

is very similar in appearance to that of an Agelenid spider. The *Avicularidae* live in hollow trees, under stones, or in burrows or natural hollows in the ground. The species which excavate a burrow rarely close the entrance with a trap-door. Table-case No. 22.

The burrows of a South American species (*Ephebopus murinus*), together with examples of the spider itself, are shown in Wall-case 7. Nests of the common bird-eating spider (*Avicularia avicularia*) of the north of South America, constructed in the hollow trunk of a palm tree, and in the rolled-up leaf of a banana, are also shown in this Wall-case, and specimens of the spider, and also of other species of bird-eating spiders, are placed in Table-case 22. Wall-case No. 7.

FAM.—*Ctenizidae.*

In the Ctenizidae the feet are not furnished with apical tufts or pads of hair. The chelicerae are furnished with digging spines.

On account of their neatness and of the ingenuity displayed in their construction, the trap-door nests of these spiders have long attracted attention. The nest takes the form of a long tunnel in the ground, the interior of which is lined with smooth silk, the entrance being often closed by a neatly fashioned trap-door, the outer surface of which exactly matches its surroundings, so that it is practically invisible when closed. The spider often constructs one or more side chambers to the burrow, and sometimes shuts them off from the main part of the tunnel by additional trap-doors, thus ensuring a place of refuge in case the outer door is forced by an enemy. Some of the species, which do not close the entrance to the nest by a trap-door, erect a turret of grass or small twigs, bound together by web, around it. In some instances (*Pseudidiops*, etc.) the trap-door spider constructs its nest on the trunk of a tree, spinning a silken tube in the crevices of the bark, and overlaying it with chips of bark and lichen, so as to strengthen its walls and to conceal it from view (Table-case 22). Most of the spiders of this family have the carapace and limbs smooth and polished, and the abdomen clothed with short dense hair, so that no impediment is offered to rapid movement in the silk-lined burrow.

Two burrows of a trap-door spider (*Actinopus wallacei*), from Brazil, are exhibited in Wall-case 7. In one of them the spider is cautiously raising the lid, on the watch for approaching prey. Wall-case No. 7.

Fam.—*Atypidae.*

Table-case No. 22.

The two genera (*Atypus* and *Calommata*) which compose this family differ from the Aviculariidae and Ctenizidae in possessing a large maxillary process upon the base of the palp The chelicerae are not usually furnished with digging spines.

The genus *Atypus* has a wide distribution, occurring in Europe, North Africa, Japan, Burma, and Java; whilst *Calommata* is found in Japan, Burma, the Sunda Islands, and West Africa.

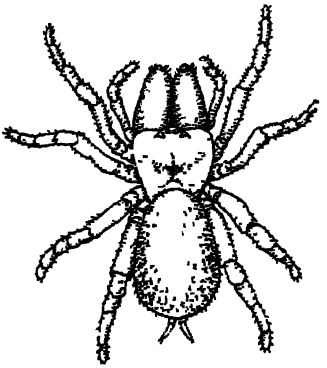


Fig. 61.

Atypus affinis × 2.

The only Mygalomorph spider which occurs in this country (*Atypus affinis*) belongs to this family. It is found in the South of England, the Channel Islands, and also in Ireland, and many places on the Continent. The nest of this spider consists of a long burrow, excavated in the ground, and lined throughout with web. This lining is continued beyond the surface as a long closed tube, which is either attached to some object near at hand or lies loosely on the surface of the ground, when flies or other insects alight on it they are seized from within by the spider, and pulled through the silk, the rent thus made being repaired afterwards. Similarly, the male enters the burrow by biting a hole in the wall of the tube.

Wall-case No 7.

A number of the external tubes of the North American purse-web spider (*Atypus abbotii*), which are spun against the trunk of a tree, are exhibited in Wall-case 7.

Tribe II.—Arachnomorphae.

Table-case No 23.

In these spiders the outer branches of the anterior pair of spinning appendages and both the outer and inner branches of the posterior pair are present, the inner branches of the anterior pair being often represented by a perforated spinning-plate (the "cribellum") or by a membranous lobe (the "colulus"). In the spiders in which the "cribellum" is present, the penultimate joint of the fourth leg is always furnished with a series of curved hairs. The chelicerae project downwards. The posterior pair of pulmonary sacs is replaced (except in the genus *Hypochilus*) by tracheal tubes, the stigmata of which may be situated immediately behind those of

the anterior pulmonary sacs, but more usually unite to form a common aperture in front of the spinning appendages. Table-case No 23.

The great majority of spiders belong to this group, and the habits are very varied in the different families. Many of the species obtain their prey by means of webs, others by stealth or by running it down. A number of species lead an aquatic or semi-aquatic life In most of the Mygalomorph spiders, and those of the Arachnomorph spiders which live a free, wandering life, the silk is only used for the fabrication of the cocoon or for lining the nest. The snares of the sedentary or web-spinning spiders vary much in structure in the different groups; sometimes they consist of a few crossing lines only, whilst in other cases, as in the orb-spinners (Argiopidae), they are of marvellous symmetry and beauty. There are numerous families; some of the more important of these are commented upon below.

FAM.—*Argiopidae* (*Epeiridae*).

The spiders of this family are sedentary in habit, catching their prey by means of webs. Some of them spin orb-webs, others

FIG. 62.

Gasteracantha formosa (slightly enlarged) (After Vinson.)

construct horizontal sheets of web or irregular networks. The species are very numerous, and present much diversity of form and colouring, many of them being of exceeding beauty. Of the species occurring in this country, the large garden spider (*Aranea* (*Epeira*) *diadematа*) is familiar to everyone, and a number of smaller forms are also abundant The species of *Nephila* are the largest Argiopid spiders They are confined to the warmer parts of the world. Their immense orbicular webs, covering several feet in area, are composed of silk strong enough to arrest the flight of small birds, which, becoming entangled, are killed and eaten by the spider. Their food consists for the most part, however, of grasshoppers and other insects. The male is ridiculously small as compared with the female. On account of his small size and great activity he is able to make his escape from her if she

Table-case No. 23.

turns upon him with murderous intent during courtship, as female spiders commonly do.

Some of the tropical Argiopidae (*Gasteracantha*, etc.) have the abdomen hardened and armed with long spines. It is believed that these are of advantage to the spider by rendering it unpalatable to birds. The male of *Gasteracantha*, which is much more retiring in its habits than the female, is not furnished with spines. Remarkable illustrations of protective resemblance are afforded by some of the species belonging to this family, as, for instance, the Rhodesian species known as *Caerostris corticosa*. In colour and general appearance this spider harmonizes with the bark of the common Rhodesian thorn-tree, on which it is commonly found, and its abdomen is furnished with processes resembling the thorns with which the tree is beset. The Argiopidae are cosmopolitan in distribution.

Fig 63

Tarsal-comb of the fourth leg of *Theridion tepidarorum*. Magnified. (After F. O Pickard-Cambridge.)

Fam.—*Theridiidae*.

These spiders differ but little in structure from the Argiopidae, but may be readily distinguished from them by the structure of the fourth leg, the terminal segment of which bears a comb of setae (fig. 63). A few of the species are remarkable in that they construct no web. The family is very numerous in species, and has a wide distribution.

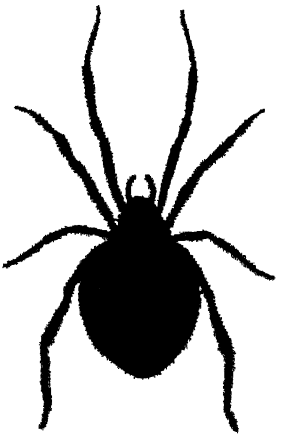


Fig. 64.

A Theridiid Spider (*Lathrodectus tredecim-guttatus*), × 2.

The genus *Lathrodectus* is, perhaps, the most noteworthy of the Theridiidae. Several of the species have the reputation of being extremely poisonous, and numerous accounts of the effects of their bite have been published. The abdomen in the poisonous species is marked with conspicuous red stripes or spots. A coloured drawing of the well-known European species (*Lathrodectus tredecim-guttatus*) is exhibited in Table-case 23.

FAM.—*Thomisidae.*

The *Thomisidae*, or Crab-spiders, as they are often called on account of their sidelong method of walking, are usually small, squat-looking spiders. They lead a wandering life, and do not construct regular snares. Many of them are sluggish in habit, and are noticeable for their protective coloration, which renders them inconspicuous to their enemies, and at the same time enables them to lie in wait for and surprise their prey. The species which live in flowers are said to be able to change their tints to suit the blossom on which they are resting; other Thomisids show close resemblance to various substances such as bark, blades of grass, the excrement of birds, etc. The Crab-spiders belonging to the sub-family *Philodrominae* are more active in habit, and trust to their speed for the capture of their prey.

Table-case No. 23.

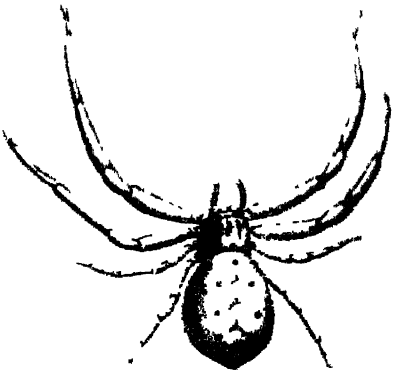


FIG. 65
Flower-spider, *Misumena vatia*, × 2.
(After Blackwall.)

A sketch in colour of a common British flower-spider (*Misumena vatia*) is exhibited in the Table-case containing the specimens of Arachnomorph spiders.

FAM.—*Clubionidae.*

The spiders of this family are often of large size, but there are a great number of small or medium-sized species. They are predatory forms, and are provided with large and powerful chelicerae. Many of them are laterigrade, and can walk either backwards or sideways at will. In the tropical regions of the world a number of large species are met with in houses, and several of them have a wide distribution. One of these house-spiders (*Heteropoda regia*) has been imported by shipping from the East Indies practically all over the world, and, like the common rat and cockroach, maintains itself wherever the conditions are favourable to its survival.

Table-case No. 23. Specimens of this spider have been found at University College, London, and also at Bristol, but since tropical conditions appear to be essential to its existence, there is little likelihood of its becoming an established species in this country. Some of the smaller forms are remarkable for the closeness with which they mimic ants. The Clubionidae are cosmopolitan in distribution.

FAM.—*I*

On account of their predatory habits these spiders are commonly known as wolf-spiders. With the exception of the species belonging to the group HIPPASEAE, which spin large webs, accompanied by tubular retreats, similar to those of *Agelena* and its allies, they do not construct snares The majority of the Lycosidae do not make a regular nest; a number of species, however, construct burrows in the ground similar to those of the trap-door spiders, and some of them surround the aperture with a tower of twigs (e.g. *Lycosa arenicola*, a species which occurs in the United States, exhibited in Wall-case 7) or grass, or even close it with a neat trap-door. The female spider carries the cocoon about with her, attached to the spinning mammillae. On leaving the cocoon the young spiders climb on to the back of the mother, attaching themselves by threads, and are carried about by her in this fashion for several days. The spider encumbered thus by her living burden presents an interesting and curious spectacle.

The name "Tarantula" is loosely applied to many large spiders of various kinds. It should really be restricted to the Italian species *Lycosa tarentula* (and its allies), which first received the name from its abundance near the town of Taranto or Tarentum. Amongst the Italian peasantry there still prevails an ancient superstition that the poisonous bite of this spider gives rise to a sickness called Tarentism. The chief specific for the malady is music, which incites the victim to dance in a frenzied and violent manner, and to continue the exercise until the outbreak of a profuse perspiration effects the cure by getting rid of the poison.

FAM.—*Agelenidae.*

These spiders are sedentary web-spinning forms. Their snare usually consists of a large horizontal sheet of web, with one or two tubular retreats leading from it. Perhaps the most familiar of them are the house-spiders (*Tegenaria*), which construct untidy

webs in the corners of cellars and out-houses. The spiders of the genus *Desis*, which occur on the coasts of South Africa, Malay Peninsula, Burma, and Australasia, are marine in habit. They live in holes and crannies in rocks or coral reefs, or under stones between tide-marks. During high tide they remain shut up in their waterproof cells of silk, leaving them at low water in search of prey. *Argyroneta aquatica*, the European water-spider, is also a member of this family. It is found in pools and ditches of fresh water, and is widely distributed in this country. On account of its interesting habits it is often kept in aquaria. Table-case No. 23

FAM.—*Eresidae.*

With the exception of the species belonging to the genus *Stegodyphus*, these spiders are all burrowing forms In the South African genus *Seothyra* the aperture of the burrow is concealed by a curious four-lobed, flexible flap or mat. The species of *Stegodyphus* live on bushes, some of them are solitary and construct a sheet-like web accompanied by a tubular retreat, other species make a large saccular nest of leaves and web, in which hundreds of individuals live together (the nest of a species from Calcutta is shown in Wall-case 7). The spiders of this family are confined to the old world A single species (*Eresus cinnaberinus*) has been found on two or three occasions in the South of England

FAM.—*Dysderidae.*

The members of this family live under stones, the bark of trees, and other retired places. They do not spin a regular web, but construct a tubular retreat or cell of silk. Nearly all of them are inhabitants of temperate or warmer temperate countries

A coloured drawing of a common British species (*Segestria senoculata*) is on exhibition in Table-case 23.

FAM.—*Salticidae*

The Salticidae are exceedingly numerous and are nearly always of small size. They are wandering forms and do not spin webs, but lie in wait for their prey or stalk it, and then seize it with a sudden jump. Many of the tropical forms are beautifully coloured; the males are often more vividly coloured than the females, and their antics when courting are often of a very curious nature. They execute intricate movements and dances before the females, moving so as to display to advantage their beauty of form and colouring.

Table-case No. 23. Of the British jumping spiders, *Epiblemum scenicum*, a species which lives in the crevices of walls, is the most frequently met with. It is often to be seen wandering about in the sunshine in search of prey.

It is to this family that the majority of the ant-like spiders belong. In the principal genus *Myrmarachne* there are more than eighty species, which are distributed over the temperate and warmer regions of the world. They often mimic particular species of ants, resembling them closely in form and colour; their gait also is very ant-like, and they habitually run in the zigzag fashion of an ant pursuing its prey. To complete the deception, the legs of the first or second pairs in some species are held up in the air so as to simulate the antennae of the insect. The family is cosmopolitan in distribution.

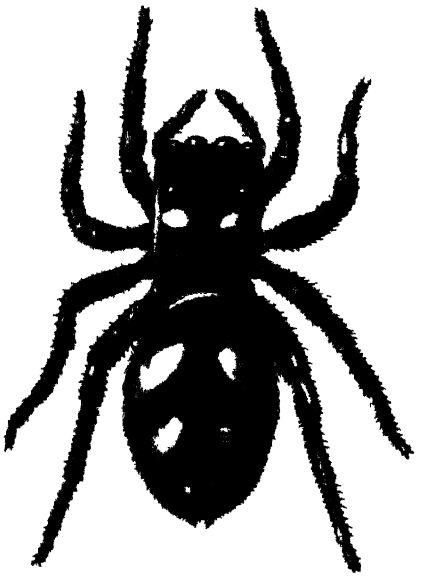


FIG. 66.
Jumping Spider, *Epiblemum scenicum*, × 8.
(After Blackwall.)

Order 5.
Solifugae (False Spiders).

The Solifugae have some superficial resemblance to the spiders, but may be easily distinguished from them by their having both the cephalothorax and the abdomen distinctly segmented and by the absence of spinning mammillae. The "cephalothorax" (prosoma) is covered by three plates. The front one of these, which represents the terga of the first four somites, is of large size and bears a pair of median eyes and obsolete lateral eyes. The ventral surface of the fourth cephalothoracic somite bears a

Table-case No. 24.

large pair of stigmata. In nearly all Solifugae the first appendage is furnished with stridulatory ridges on its inner surface, and in the adult male its dorsal surface is almost always provided with a curious chitinous structure, the "flagellum," which differs much in shape in the various genera. The palp, which is of large size, has a suctorial organ on its terminal segment. A number of peculiar chitinous racket-shaped structures, the "malleoli," are present on the lower surface of the basal segments of the fourth leg The "abdomen" (opisthosoma) is composed of ten distinct somites and the ventral surface of the second and third of these is furnished with paired tracheal stigmata, while an additional unpaired stigma is often present on the fourth.

Table-case No. 24

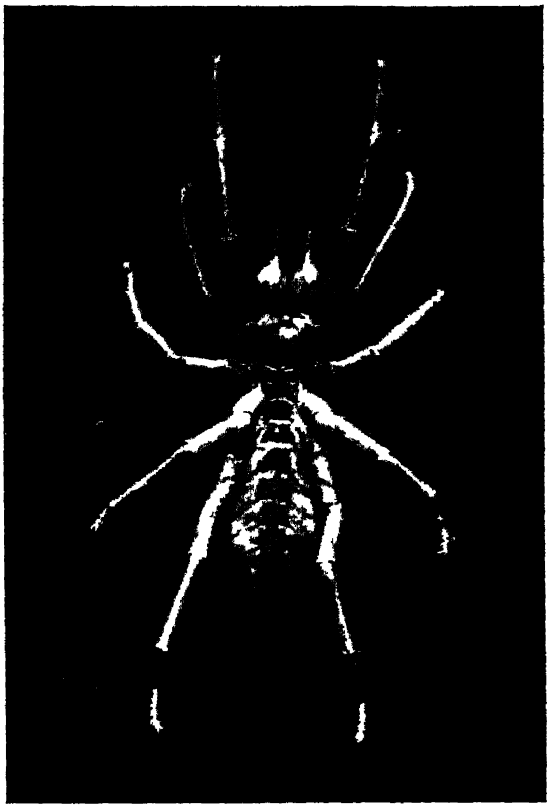


FIG 67.

Galeodes arabs (three-fourths natural size).

The Solifugae are typically desert forms, but a few species are believed to occur in forests. After nightfall in the tropics the nocturnal species are often found in houses or tents to which they have been attracted by the artificial light. Many species are diurnal, and may be seen darting about with amazing speed in search of prey during the hottest part of the day. They are venomous, the mandibles being devoid of poison glands. They are oviparous.

Solifugae occur in most of the tropical and warmer regions of

Table-case No. 24.

the world. In Europe they are found in Spain, Greece and Southern Russia, whilst in America, they are distributed from the Southern States of the Union to the Andean Chain in Chile and the Argentine Republic. They are entirely absent from Australasia, China and Japan.

There are three families:—1. *Galeodidae*; 2 *Solpugidae*; 3. *Hexisopodidae.*

FAM.—*Galeodidae.*

In the Galeodidae, the flagellum of the first appendage is always lancet-shaped. Large hairy claws are present on the legs of the three posterior pairs. A narrow toothed plate protects the stigmata of the second and third abdominal somites.

There is but a single genus (*Galeodes*) in this family The species are very numerous and are confined in distribution to the Old World. They are all quick-running forms.

Examples of *Galeodes arabs* (Fig. 67), a North African species, with a wide distribution, are placed in Table-case 24

FAM.—*Solpugidae*

In this family the flagellum presents much diversity of form. The claws of the three posterior legs are smooth There is no toothed plate above the stigmata of the second and third abdominal somites.

There are numerous genera and species of Solpugidae and they have a wide distribution. The genus *Solpuga*, which is confined to Africa, is the richest in species. The majority of the members of the family are very active in habit, but a number of species (*Rhagodes*, etc.) are slow and clumsy in movement.

FAM.—*Hexisopodidae.*

These Solifugae have the legs of the fourth pair without claws The abdominal stigmata have no plates above them.

The two genera (*Hexisopus* and *Chelypus*) which compose this family are confined to the dry regions of South Africa, and four or five species only are known. Unlike the great majority of Solifugae, they are slow-moving forms.

Order 6.—Pseudoscorpiones (False Scorpions).

These Arachnida are very like little tailless scorpions in general appearance, but in reality they differ from the scorpions in many important characters. The "cephalothorax" (prosoma) is covered

by a single plate, which, however, sometimes shows traces of segmentation. There are no median eyes, but one or more lateral ocelli may be present. The fingers of the chelicerae are furnished with delicate membranous structures called the "serrula" and "lamina" respectively. The movable finger of the mandible is furnished with a branched or styliform structure called the "galea," or with a little terminal tubercle; and it is on this structure that the orifices of the silk-glands debouch. The palps are large and chelate, as in the scorpions. There is no constriction between the cephalothorax and the abdomen (opisthosoma), but the large dorsal plate of the praegenital segment (which is generally suppressed in the Euarachnida) lies between these two regions. Eleven abdominal somites can often be distinguished, and none of them are narrowed to form a tail, but the last of them is very small and is often hidden within the segment which precedes it. Table-case No. 24.

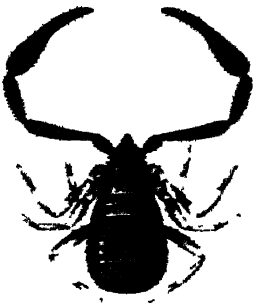


Fig. 68.

Chelifer cancroides, × 5
(After Berlese)

The Pseudoscorpions are small Arachnids, which live under stones or the bark of trees or in moss. They are occasionally found in houses, amongst books, etc., and several species have been found on merchant-ships, not uncommonly specimens may be met with clinging to the legs of flies or beneath the wing-cases of beetles. One of the British species (*Obisium maritimum*) is found under stones or beneath seaweed below high-water mark. Their food consists of mites or small insects. At the breeding season the female envelops herself and her eggs, which she attaches to the under side of her body, in a spacious silken cell.

A similar cell is spun as a protection whilst the animal is moulting and during hibernation.

The earliest-known fossil forms of Pseudoscorpions are from amber deposits of Oligocene age. At the present day the group is distributed all over the temperate and tropical countries of the world.

It is divisible into two sub-orders: (1) *Panctenodactyli*, (2) *Heterodactyli*. Drawings illustrating the main points of difference between these sub-orders are placed in Table-case 24.

Sub-order I.—PANCTENODACTYLI.

Table-case No. 24.

The members of this sub-order have the first appendage of small size, and the serrula of the movable finger is fused throughout its length to the finger.

There are three families: (1) *Garypidae*, (2) *Feaellidae*, (3) *Cheliferidae*. Specimens of a large species of *Chelifer* from Sierra Leone are exhibited in Case 24.

Sub-order II.—HEMICTENODACTYLI.

The first pair of appendages of the *Hemictenodactyli* is of large size, and at least the distal end of the serrula of the movable finger is free.

There are two families (1) *Chthoniidae*, (2) *Obisiidae*.

Order 7.—Podogona.

Owing to a close, but superficial resemblance to certain species of Opiliones the Podogona were regarded, until quite recently, as forming part of that order. The anterior of the two plates, which form the carapace of the cephalothorax (prosoma), is of small size and forms a movable hood, which covers the mouth and first pair of appendages. The palps are weakly chelate. A movable membranous joint unites the cephalothorax and the abdomen, the genital aperture opening upon the ventral surface of this membrane. The abdomen (opisthosoma) consists of only four visible segments, in addition to a tubular ring encircling the anus. A striking peculiarity of these animals is the position of the copulatory organs, one of which is placed at the end of each walking-leg of the third pair. A single pair of respiratory spiracles, which is situated towards the posterior end of the cephalothorax, is present.

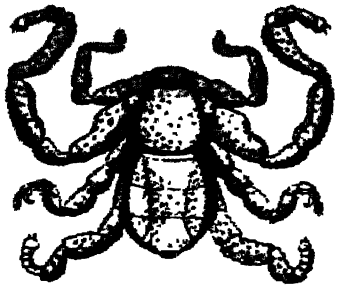


Fig. 69.

Diagram of a species of *Cryptostemma*, to show the characters of the Podogona. (× 4.)

A specimen of a West African species (*Cryptostemma karschi*) (and also enlarged drawings of the species) are also exhibited in Table-case 24.

The existing species of Podogona are referable to the family *Cryptostemmatidae*. They are small Arachnids, barely reaching half an inch in length, and are confined to the forest-clad tracts of tropical West Africa and Brazil. Table-case No. 24.

The group was represented in the Carboniferous period by the genus *Poliochera*.

Order 8.—Opiliones (Harvest-men).

In the Opiliones the "cephalothorax" is confluent with the abdomen throughout its width, and its carapace is either unsegmented or divided into two segments. Paired stink-glands open on its dorsal surface near the lateral margins. The palp is not chelate. The abdomen is clearly segmented, the somites sometimes numbering as many as ten. Respiration is carried on, as in the Pseudoscorpions, by means of tracheal tubes which open by a pair of stigmata on the sternal plate of the abdomen. Table-case No. 25

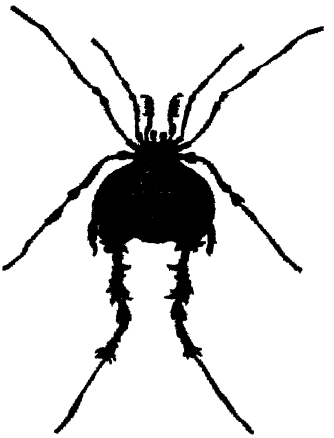


Fig. 70.

Gonyleptes chilensis.

Most of the Opiliones are of rather small size, but some of the South American species reach considerable dimensions. They are exclusively carnivorous, feeding upon insects, worms, and the like. The female lays her eggs in crevices of the soil, or any damp place, and leaves them to their fate.

The extinct Arachnida known as the *Anthracomarti*, which occur in the Carboniferous strata, are perhaps allied to the Opiliones. A cast and drawings of one of these fossil forms are exhibited in the Table-case (No. 25) with the Opiliones, and several casts and specimens are shown in the Geological Department (Gallery 8, Table-case 23).

Sub-order I.—LANIATORES.

In these Opiliones the palp is often stout and furnished with a strong prehensile claw. There is a single claw on each of the

Table-case No. 25.

legs of the first pairs, but the legs of the posterior pairs have two claws (except in the family *Triaenonychidae*, in which all the legs are furnished with a single claw, which differs, however, from that of the Palpatores in being armed with lateral processes).

The Laniatores (see Fig. 70) are divided into a number of families and have a wide distribution; they are mostly tropical forms and are especially numerous in South America. A few small species occur in Europe and North America.

Sub-order II.—PALPATORES.

In the Palpatores the palp is slender and the claw is small and weak; it is used as a tactile organ. A single claw is present on the legs of all four pairs.

The sub-order Palpatores, which is cosmopolitan in distribution, and comprises almost all the European species, is the only one which has representatives in Great Britain. There are twenty-three or twenty-four British Opiliones, and nearly all of them belong to the family *Phalangiidae*. One of them (*Phalangium opilio*) is common on walls, and other species are abundant under stones, amongst herbage, grass, etc.

Fig. 71.
Stylocellus sumatranus.
× 2.

Perhaps the most remarkable of the members of this sub-order are those belonging to the family *Trogulidae*. They are hard-skinned forms and have the front part of the cephalothorax produced forwards to form a hood, which conceals the mouth and chelicerae. Two genera (*Anelasmocephalus* and *Trogulus*) belonging to this family have been found in this country.

Sub-order III.—ANEPIGNATHI.

One of the most important distinguishing characters in these Opiliones is the position of the orifices of the stink-glands, which are placed on the summit of prominent cones or tubercles. By the earlier students of the group these cones were mistaken for stalked eyes. The palp is slender and its claw minute.

There is a single family, the *Sironidae*, the members of which chiefly occur in the East Indies and Ceylon. A species has also been found in South Africa, and another on the West Coast of

Africa In Europe they are known from Austria, France and Corsica. Table-case No. 25.

Drawings of *Stylocellus sumatranus*, to illustrate the structure of the Anepignathi, are exhibited in Table-case 25.

Order 9.—Acari (Mites and Ticks).

These Arachnida, which show many traces of degeneration, are most closely allied to the Opiliones. The cephalothorax and abdomen are completely fused with one another, and the latter region is usually without any trace of segmentation. The appendages of the first pair vary in structure, being sometimes chelate, sometimes styliform, and often retractile beneath the fore border of the cephalothorax; the basal segments of the appendages of the second pair are fused beneath the mouth and project forwards below, uniting laterally with the "camarostome," or "rostrum," to form a suctorial proboscis. Table-cases Nos. 25-26.

The Acari are mostly of small, or even microscopic size. Some live a free and predatory life; others are parasitic for the whole or part of their lives upon plants or animals.

From an economic standpoint many of the Acari are of considerable importance on account of the injury they inflict upon plants; and the Ticks are now known to be of great importance in the transmission of certain diseases of man and domesticated animals, more especially in tropical countries.

They are divisible into the following sub-orders :—

1. *Notostigmata.*
2. *Cryptostigmata.*
3. *Metastigmata.*
4. *Prostigmata.*
5. *Astigmata.*
6. *Vermiformia.*
7. *Tetrapoda.*

Sub-order I.—NOTOSTIGMATA.

In the Notostigmata the abdomen consists of ten segments, which are defined by grooves in the integument, the four anterior of them being furnished dorsally with paired tracheal stigmata. To this sub-order belongs the single family *Opilioacaridae.*

These mites have been found under stones in Algeria, Italy, Arabia and South America. They are not parasitic.

A drawing of *Opilioacarus segmentatus* is exhibited in Table-case 25.

Sub-order II.—CRYPTOSTIGMATA.

Table-case No. 25.

Acari with the tracheal spiracles situated in the articular sockets of the four pairs of locomotory appendages. The integument is thickly and continuously chitinized, and shows no sign of segmentation.

This sub-order contains the single family *Oribatidae*, sometimes known as beetle-mites, on account of their hard, black, shiny integument They are not parasitic, but live in moss, under stones, etc., in damp places.

An enlarged drawing of an Oribatid mite (*Notaspis bicolor*) is on view in Table-case 25.

Sub-order III.—METASTIGMATA.

Acari with the tracheae opening by a pair of stigmata, situated above and behind the base of the fourth or fifth or sixth pair of appendages. This sub-order contains two families: *Gamasidae*, *Ixodidae*.

Fam.—*Gamasidae*.

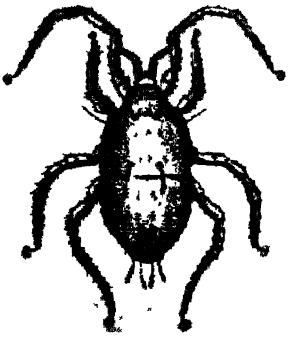


Fig. 72.

Table-case No. 26.

Gamasus coleoptratorum (magnified). (After Berlese.)

There is no serrated beak in these mites.

They live for the most part a non-parasitic life in damp or moist localities, and prey upon organisms smaller than themselves. Many of them are found habitually upon large insects, like beetles, but apparently for the purpose of locomotion, not of parasitism. Some members, however, are parasitic upon mammals and birds.

Fam.—*Ixodidae*.

The coalesced basal segments of the appendages of the second pair are produced in front into a cylindrical piercing process, or beak, furnished with recurved teeth. The appendages of the first pair are still pincer-like, but are much modified.

The Ixodidae, or Ticks, live as temporary parasites upon mammalia, birds and reptiles, whose blood they suck by burying their mandibles and beak in the skin. The females quit their host

to lay their eggs upon the ground, under stones, in grass, the crevices of walls, etc. The Ixodidae are divided into two sub-families. Table-case No. 26.

Besides the specimens of Ixodidae exhibited in Case 26, a few specimens are on view in the North Hall.

Sub-fam.—*Argasinae.*

In the Argasinae the jaws are overlapped by a forward expansion of the body, and the skin is leathery and coriaceous; the male and female are very similar in appearance (Genera: *Argas* and *Ornithodoros*).

The Argasinae are chiefly parasitic on human beings, birds, and bats. The human tick-fever of tropical Africa (Spirillosis) is conveyed by the species known as *Ornithodoros moubata*; the fowl-tick (*Argas persicus*) is also known to transmit spirillosis amongst its hosts.

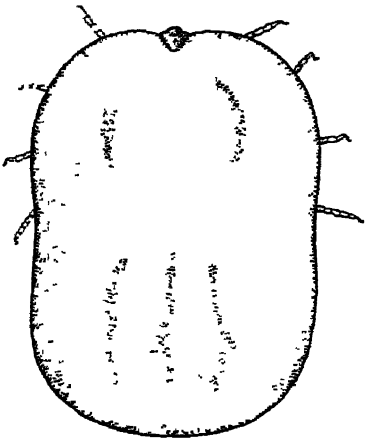


Fig 73.

Margaropus annulatus, the Cattle Tick; distended female, × 5. (After Salmon and Stiles.)

Sub-fam.—*Ixodinae.*

The mouth-parts of the Ixodinae are terminal The skin is smooth; a firm chitinous shield covers the whole of the back of the male, but leaves a considerable portion of that of the female uncovered.

Several of the members of this family are known to convey infectious diseases; perhaps the most important of these is the cattle-tick (*Margaropus annulatus*), a widely distributed form, which is the carrier of Texas-fever (Piroplasmosis).

Sub-order IV.—PROSTIGMATA.

Acari with a single pair of tracheal stigmata, which are situated on the anterior part of the body (except in the Halacaridae, in which the tracheae are absent).

The Acari of this group differ greatly in their habits; most of them are free-living and are found in moss, under stones, on plants, etc. They chiefly feed upon vegetable substances, but many of them prey on minute animals. There are four families: ***Trombidiidae, Hydrachnidae, Halacaridae,*** and ***Bdellidae.***

Fam.—*Trombidiidae.*

Table-case No. 26

The Trombidiidae are soft-skinned mites, the palpi are free, the penultimate (or, more rarely, the last) segment being armed with a claw

Most of the mites of this family are free-living forms, which are either predatory or herbivorous. A few species are parasitic upon vertebrates and insects. The species of *Trombidium* are clothed with long, red, velvety hair, and present a striking appearance. The European representatives of the genus are of small size; in the tropics, however, large species, measuring about half an inch in length, occur. The harvest-bugs, which cause irritation in autumn by burrowing under the skin, are six-legged larvae belonging to various species of Trombidiidae. The spinning-mites (*Tetranychinae*), which occur in immense numbers on various kinds of plants, cause much damage to vegetation. They spin a fine web, which is usually found coating the lower side of leaves. The bright glaze, which may sometimes be seen on the trunk and branches of the lime tree, is produced by one of these mites (*Tetranychus telarius*)

Fam.—*Hydrachnidae.*

The Hydrachnidae, or water-mites, resemble the Trombidiidae closely in structure. The legs are furnished with swimming-hairs.

Most of the Hydrachnidae live in fresh water, but there are a few marine species. Their food consists of small crustacea, insect larvae, infusoria, etc. They are widely distributed and there are numerous British species.

Fam.—*Halacaridae.*

In the Halacaridae the buccal organs are carried on a distinct rostrum; the appendages of the first pair are either styliform or chelate, and the terminal segment of the palp is conical or styliform. The skin is strengthened by a number of dorsal and ventral plates.

These mites are chiefly marine in habit, but a few species occur in fresh water. They do not swim, but crawl on algae and marine animals. They were first made known by Mr. Gosse, who described several British species in the year 1855.

Table-case No. 26.

FAM.—*Bdellidæ.*

The members of this family are soft-skinned mites, with a distinct rostrum. The first pair of appendages are in the form of pincers and the palps are slender and unarmed.

These mites are free-living terrestrial forms, which lead a predatory life. There are a number of British species. A little red species (*Bdella littoralis*) is common on our sea-coasts.

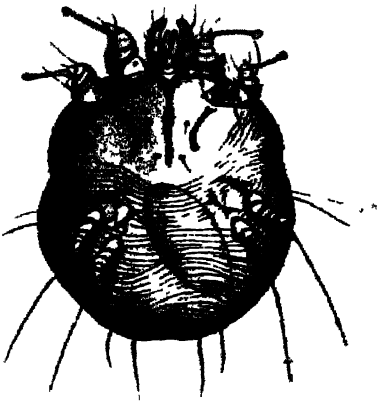


FIG. 74.

Sarcoptes scabiei, the itch mite, × 100 (after Canestrini).

SUB-ORDER V.
ASTIGMATA.

In these Acari, which are closely allied to the *Prostigmata*, there is no trace of a respiratory system

Many of them are parasitic, others are free-living and feed on animal and vegetable refuse. It is to this sub-order that the mite (*Sarcoptes scabiei*) which is the cause of itch belongs. The cheese mite (*Tyroglyphus sro*) is perhaps the most familiar of the non-parasitic forms. Another species (*Glycyphagus domesticus*) is often found in houses. Drawings of these two species are shown in Table-case 26.

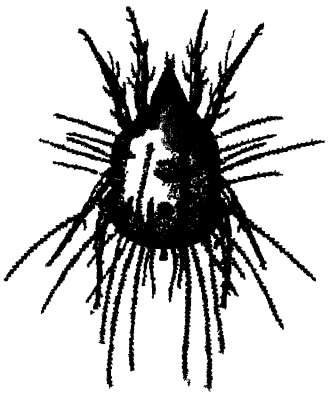


FIG. 75.

House-mite, *Glycyphagus domesticus*, × 50 (after Michael).

A tuft of wool, with some of the flesh still attached, showing the scab caused by a Sarcoptid mite (*Psoroptes communis*, var. *ovis*), together with drawings of the mite itself, is on view in the North Hall.

Sub-order VI.—VERMIFORMIA.

Table-case No. 26.

The Acari belonging to this sub-order are degenerate, parasitic forms without tracheae, and with the posterior portion of the body produced into an annulated caudal prolongation. The third, fourth, fifth, and sixth pairs of appendages are short and three-jointed.

The sub-order includes the single family *Demodicidae*, the members of which live in the sebaceous glands of the skin of man and other mammals. A drawing of *Demodex caninus*, a species which gives rise to follicular mange in dogs, is exhibited in Table-case 26. This mite is about one-eightieth of an inch in size.

Fig. 76.

Demodex caninus, ventral view of female Greatly magnified (after Canestrini).

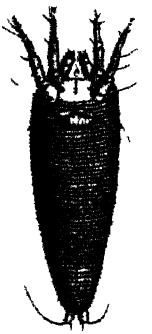


Fig. 77.

Ventral view of a gall-mite, *Eriophyes silricola*, × 135 (after Canestrini)

Sub-order VII.—TETRAPODA.

These mites are degenerate forms, which resemble the Vermiformia in being without tracheae and in having the body prolonged and annulated The legs of the first two pairs are long and provided with the normal number of segments, but those of the third and fourth pairs are absent.

To this sub-order belong the gall-mites, which form a single family, *Eriophyidae* (*Phytoptidae*). They are of very small size and are exclusively parasitic on plants of various kinds : many of them give rise to pathological conditions resulting in scars, galls, or

other excrescences of the stem or leaves, but a number of species are wandering forms, or live in the galls of other species. Table-case No. 26.

A drawing of one of these mites (*Eriophyes silvicola*), which produces galls on the leaves of the stone-bramble (*Rubus saxatilis*), is placed in Table-case 26, and models of some of the commoner galls, and enlarged sketches of the mites which cause them, are shown along the wall to the left of the Case. Drawings of the black-currant mite (*Eriophyes ribis*) and of the plum mite (*Eriophyes pruni*), together with specimens of the plants they infest, showing the damage which they cause, are shown in the North Hall.

Sub-class 2.—PYCNOGONIDA.

The Pycnogonida, Pantopoda, or Podosomata, are a small group of marine animals, here treated as a sub-class of the Arachnida,

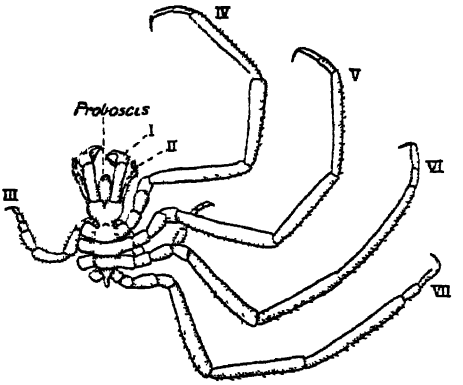


FIG. 78.

Diagram of a Pycnogonid, *Nymphon* (*Boreonymphon*) *robustum* Enlarged [Table-case No 26]

although it should be mentioned that many zoologists refuse to admit that they have any close affinity with that group of animals.

The body (Fig. 78) consists, as a rule, of a head-segment, followed by three free somites and a small terminal lobe representing the abdomen or opisthosoma. Four pairs of very long legs (IV.-VII.) are attached, the first to the head-segment, and the others to the three free somites. In addition, the head-segment may bear three pairs of appendages; the first pair (I) are chelate (or pincer-like), and overhang a tubular proboscis on which is the opening of the mouth; the second pair (II.) are sensory palps, placed at the sides of the proboscis; the third pair (III.), placed

Table-case No. 26

just behind the last, are used, in the male sex, for carrying the eggs, and are known as "ovigers." One or other of the first three pairs, or (in the female sex) all of them, may be absent in certain genera.

The apparent resemblance of a Pycnogonid to an Arachnid is due chiefly to the four pairs of long and slender legs, and to the chelate form of the first pair of appendages. The comparison, however, is complicated by the fact that the Arachnida possess but one pair of appendages, the pedipalps, between the chelicerae and the first legs, while the Pycnogonida have two pairs, the palps and the ovigers, in the same position. A further serious difficulty in the way of comparison is raised by the existence, in Antarctic seas, of two genera, *Decolopoda* (Fig. 79) and *Pentanymphon*, which have five, instead of four, pairs of legs, and four free somites behind the head.

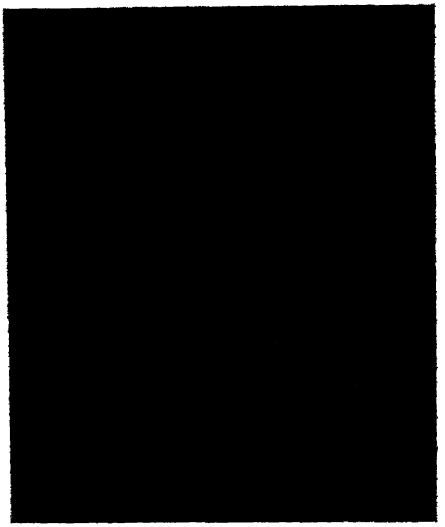


Fig. 79.

Decolopoda australis, a ten-legged Pycnogonid from the Antarctic Seas. Slightly reduced. Table-case No. 26.

The internal structure presents many exceptional features, which are illustrated by the drawings exhibited above the Table-case. The food-canal sends long diverticula into the appendages, and the generative glands also are partly situated in the legs and open to the exterior by pores on the second segments of some or all the pairs. A remarkable fact in the breeding habits of these animals is that the eggs are carried, after deposition, not by the female, but by the male, attached in clusters to the third pair of appendages.

The Pycnogonida are all marine animals, ranging from shallow water to depths of at least 2,000 fathoms. They are especially abundant in the Arctic and Antarctic regions. The specimens exhibited include *Pycnogonum littorale*, which is common between tide-marks on the British coasts; *Nymphon* (*Boreonymphon*) *robustum* (Fig. 78), a characteristic Arctic species; two species of the deep-sea genus *Colossendeis*, which includes the largest of the Pycnogonida; and the ten-legged *Pentanymphon* and *Decolopoda* already alluded to.

APPENDIX TO ARACHNIDA.

PENTASTOMIDA.

The Pentastomida, or Linguatulida, represented in Wall-case 7 by *Pentastomum armillatum* from an African python, and *Linguatula taenioides* from the nose of the dog, are always parasitic, and have been so much modified by this habit that there is little left to show their affinity to the Arachnida. The segmentation of the body, and the hooks on either side of the mouth, are the sole external indications of their relationships. The third preparation, showing the young in the visceral membranes of a mammal, forms an interesting link in the life-history

Wall-case No. 7.

FIG. 80.

Pentastomum armillatum. (Natural size.)

of these creatures; it appears that the python gets its lung-parasite from eating a small mammal; the parasite becomes sexually mature in the lung of its new host, and the eggs from the lung are coughed out, and are taken up by the mammal, when in search of food.

The external ringing of the body does not correspond with any internal segmentation; the characteristic hooks are capable of protrusion and retraction; the only sense-organs are some paired papillae on the head; the sexes are separate, and the eggs are considerably developed before they are laid.

Class 4.—ONYCHOPHORA.

Wall-case (see plan on p. 10).

THIS division of the Animal kingdom is represented by a number of forms closely resembling one another in appearance and habits, and for a long time known by the general name of *Peripatus*. In recent years the differences between them have been accentuated by systematists. Examples are shown of *Peripatus* from Jamaica, of *Peripatopsis* from the Cape of Good Hope, and of *Eoperipatus* from Malacca; while figures illustrative of the natural habit are given of *Peripatopsis capensis*, of *Eoperipatus viridimaculatus* from New Zealand, and *Paraperipatus* from New Britain. It will be seen, therefore, that the distribution of this form is extremely wide,

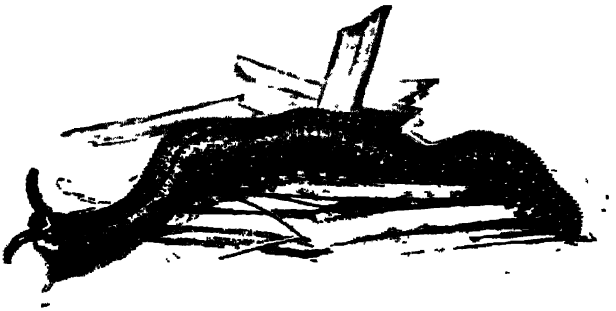


FIG. 81.

Peripatus braziliensis. (Natural size; from life.)

and, like other widely distributed forms, it gives indications of being a very primitive type.

The history of the discovery of its affinities is one of the most interesting pages in the history of Zoology. First discovered by Guilding, it was, from its shape and habits, regarded as a slug; later on, attention was directed to the fact that the body consisted of a series of successive segments, and the question was hotly discussed as to whether it was more nearly allied to the ringed worms or to the centipedes: against their alliance with the latter there was the weighty objection that nearly all the muscles of Peripatus were plain, and not banded. Up to the year 1873 no living specimen had been examined by any anatomist; in that year, however, during the voyage of H.M.S. "Challenger," H. N. Moseley, one of

the most gifted naturalists of his time, had the opportunity of dissecting freshly killed specimens at the Cape of Good Hope. Wall-case (see plan on p. 10).

When opened under water a glistening appearance revealed the presence of air-tubes, such as are found among insects, spiders and centipedes, and nowhere else in the animal kingdom; but, whereas in these three groups the air-tubes (or tracheæ) are supported by a spiral coil of chitin which keeps them open after preservation in spirit, those of Peripatus are not so supported.

Fortunately also this Peripatus was viviparous, and, as the anatomical drawing in the case shows, a number of eggs were found in the oviduct; these are in various stages of development. following them out Moseley was able to see that the first of the appendages are converted into mouth-organs. This is a character which distinguishes the centipede from the ringed worm, and so far settled the question of the relationship of Peripatus. But Moseley did more than this, he showed that Peripatus belonged to that division of the Arthropoda which is known as Tracheata, and which consists of scorpions, centipedes, flies and their allies. During the last quarter of a century much attention has been paid to the Onychophora, of which more than 50 species are now known

Peripatus is to be found in moist and shady places. It avoids light, and is nocturnal in its habits On irritation, it shoots out fine threads of a tenacious milky fluid, not unlike the threads of a spider's web This fluid is sticky enough to hold fast flies. In moving it never wriggles, but has a gait extremely like that of a caterpillar.

There are a number of more or less minute characters by which the species are distinguished from one another The most remarkable difference perhaps is in the characters of their eggs. In the Neotropical species, represented here by *P. juliformis*, the egg is minute, and almost entirely devoid of yolk. In the Cape species (*Peripatopsis capensis*) the eggs are larger and there is some yolk. In the eastern species (e.g., *Eoperipatus horsti*) the egg is large, and there is a quantity of food-yolk. One at least of the Australasian species lays eggs, which are hatched outside the body. The species vary further in the number of legs, and also in the constancy or inconstancy of the number; that is to say, some species have a definite number of legs, while others vary considerably in the number that they possess.

The group is of great scientific interest as a clear link between Arthropods and Polychaete worms.

MYRIOPODA.

Table-case No. 27.

The classes which are included together under the name Myriopoda are divided into two main divisions The first of these contains the forms in which the genital aperture is situated in the anterior part of the body (Diplopoda, Pauropoda, and Symphyla). The second division contains the Chilopoda, in which the genital aperture is situated at the posterior end of the body near the anus, as in the insects.

Owing to the importance attached to this character, some authorities do not recognise the Myriopoda as a natural group.

Class 5.—DIPLOPODA (Millipedes).

The Diplopoda are terrestrial Arthropoda, which breathe atmospheric air by means of tracheal tubes. The body-segments are numerous and, except at the anterior end of the body, each bears two pairs of legs (whence the name of the class), probably owing to the coalescence of adjacent segments in the course of development. The genital orifice is situated in the anterior part of the body between the second and third segments of the body. The head bears a pair of antennae. In the *Chilognatha* the mouth-parts consist of a pair of jointed mandibles, and a single quadrate plate, the "*gnathochilarium*," probably representing two pairs of maxillae. In the *Pselaphognatha*, however, the mandibles are followed by a pair of maxillulae, a pair of maxillae, and a labium, the latter probably representing a second pair of maxillae.

The Diplopoda are all plant feeders, and none of them are venomous. On the other hand, many of them possess stink-glands, placed along the sides of the body, which secrete an offensively smelling fluid. With the exception of the Pselaphognatha they are slow-moving forms. There are two sub-classes.

Sub-class I.—PSELAPHOGNATHA.

The members of this sub-class are small, soft-bodied forms, in which the body is composed of eleven segments and bears thirteen pairs of legs. The upper surface of the head and body-segments is furnished with a number of flattened scale-like hairs,

and large tufts of similar hairs project from the sides of each segment; the last segment is furnished with a tuft of long hairs. The mouth-parts consist of paired mandibles, maxillulae and maxillae and a labium. Table-case No. 27.

FIG. 82.

Polyxenus lagurus, the English bristly millipede, × 12

These curious little millipedes are widely distributed, and live beneath stones or the bark of trees. There is a single family, *Polyxenidae*, with two genera; one species (*Polyxenus lagurus*) occurs in this country.

Sub-class II.—CHILOGNATHA.

The body of the Chilognatha is hard and strongly chitinized, and is not furnished with tufts of scale-like hairs. The maxillae usually fuse to form a complicated gnathochilarium.

There are three orders of Chilognatha

Order 1.—Oniscomorpha.

The body is short and stout in the Oniscomorpha, and there are eleven, twelve or thirteen dorsal plates, the last of them being of large size. The copulatory feet of the male are situated on the penultimate segment The tracheal tubes are branched, and there are no stink-glands.

In general appearance the smaller species resemble closely the "wood-lice," which belong to the widely different group of the Crustacea Isopoda (see p. 43), and, like them, are able to roll themselves into a ball. They are widely distributed, but are very rare in America. The typical dark variety of *Glomeris marginata*, the Pill-Millipede, occurs in Great Britain and Ireland. In Southern Europe a large number of sub-species and varieties of *Glomeris*

FIG. 83

Sphaerotherium punctatum (slightly enlarged).

Table-case No. 27.

have been distinguished by differences in colour. The tropical forms (*Sphaerotherium*, *Zephronia*, etc.), occurring in South Africa, Madagascar and South East Asia, are often of large size.

Order 2.—Limacomorpha.

In the Limacomorpha the body tapers anteriorly and posteriorly and the segments number from nineteen to twenty, the dorsal plate of the last of them being of small size. The copulatory feet are situated on the penultimate segment. The tracheae are branched, and there are no stink-glands.

The small slug-like millipedes belonging to this sub-order occur in Java, Sumatra, and South America. As yet only three or four species are known; they form a single family, *Glomeridesmidae*, with two genera, *Glomeridesmus* and *Zephroniodesmus*.

Order 3.—Helminthomorpha.

The form of the body varies greatly in the Helminthomorpha, and the number of segments varies from nineteen to over a hundred in the different forms. The auxiliary copulatory organs of the male are situated on the seventh, on the seventh and eighth, or on the sixth, seventh and eighth segments. The tracheal tubes are not branched, but tufted. There are five sub-orders.

Sub-order I.—LYSIOPETALOIDEA.

The body of these millipedes is slender and sub-cylindrical, and the number of segments is large and variable. They have a wide distribution.

Sub-order II.—COLOBOGNATHA.

The Colobognatha differ from the other sub-orders of Helminthomorpha in that the mandibles and gnathochilarium are simplified, the mouth-parts being more or less of a suctorial type. The segments are numerous, and stink-glands are present. They are found in the tropical or warmer temperate countries of the globe. There are two families: *Platydesmidae* (*Platydesmus*, etc), and *Siphonophoridae* (*Siphonophora*, *Polyzonium*, etc.).

Sub-order III.—CHORDEUMOIDEA.

In the Chordeumoidea there are always either thirty or thirty-two body-segments, bearing symmetrically placed bristles. Stink-glands are absent. The Chordeumoidea are chiefly European and North American forms. The sub-order is represented in this country by two species, the better known being *Atractosoma polydesmoides*.

Sub-order IV.—IULOIDEA.

The body is elongated and cylindrical in these millipedes, and the number of segments differs greatly in the various forms. Stink- Table-case No 27.

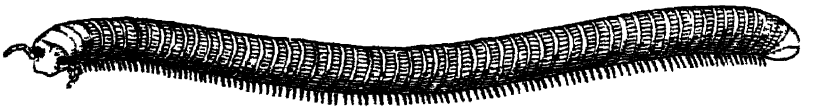


Fig. 84.

Iulus varius. Natural size. (After Koch.)

glands are present. In the male the seventh segment is limbless. In the tropical regions some of the Iuloidea (of the families *Spirostreptidae* and *Spirobolidae*) are of large size, one or two species reaching a length of over ten inches. There are numerous representatives in temperate countries. A number of species occur in this country, and several of them are injurious to vegetation.

Sub-order V.—POLYDESMOIDEA.

In the millipedes belonging to this sub-order the body is either long or short, cylindrical or rather flattened above, and is often furnished with keels: the number of segments is constant, and is either nineteen or twenty, the seventh segment of the male being furnished with a single pair of feet. The species which inhabit temperate countries are of small size, but the tropical species (*Platyrrhachus*, etc.) are often of large size and beautifully coloured. The sub-order is cosmopolitan in distribution; there are several British species, which mostly belong to the genera *Polydesmus* and *Brachydesmus*.

Fig 85.

Polydesmoid millipede, *Eurydesmus angulatus*. Slightly enlarged. (After Saussure)

Class 6.—PAUROPODA.

The members of this class differ from the Diplopoda in having branched antennae. They are all very minute animals, mostly measuring less than one-twentieth of an inch. The body-segments

Table-case No. 27.

are twelve in number and there are nine pairs of limbs. The genital aperture is on the third segment.

The Pauropoda were first discovered by Lord Avebury (Sir John Lubbock), who found two species in London in 1866. He says that, "*Pauropus huxleyi* is a bustling, active, neat and cleanly creature. It has, too, a look of cheerful intelligence, which forms a great contrast to the dull stupidity of the Diplopods, or the melancholy ferocity of most Chilopods" They are found amongst decaying leaves in damp earth, and other similar situations. Owing to their small size and fragility of structure, and to their retiring habits, they are still very incompletely known. They have

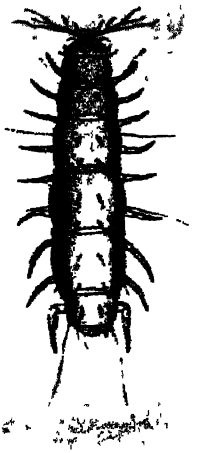


FIG. 86.
Pauropus huxleyi, × 24
(After Lubbock)

FIG. 87.
Scutigerella immaculata, × 8
(After Latzel.)

been found in Europe, tropical Asia, and North and South America, and it is possible that they have a very wide distribution. There are three families. Drawings of *Pauropus* and *Eurypauropus*, to illustrate the morphology of the Pauropoda, are placed in Table-case 27.

Class 7.—SYMPHYLA.

In the Symphyla the generative apertures are situated at the anterior end of the body, as in the Diplopoda and Pauropoda. The antennae are long, unbranched, and many-jointed. There are fifteen or sixteen body-segments, twelve pairs of legs, and four pairs of mouth-appendages.

These minute Myriopods have a wide distribution; they have been found in Europe, India, Java, Sumatra, South Africa and America. A few species occur in this country. There is a single family, *Scolopendrellidae*, with two genera, *Scolopendrella* and *Scutigerella*. Table-case No. 28.

Class 8.—CHILOPODA (Centipedes).

In the Chilopoda the body consists of a number of similar segments, and with the exception of the last, each of them is provided with a pair of appendages. The generative organs open upon the penultimate segment, behind the legs of the last pair. The anterior extremity is differentiated into a head which bears a single pair of antenniform, many-jointed, pre-oral appendages. The anterior four pairs of post-oral appendages are modified as jaws, the first pair being the bi-segmented biting mandibles, the second pair the biramous foliaceous maxillae, the third pair the leg-like palpi, or "palpognaths," and the fourth pair the powerful biting poison-jaw, or "toxicognaths." The rest of the appendages are locomotor in function, and are tipped with a single claw; those of the last pair, however, are sometimes modified in various ways in relation to sex or otherwise.

The Chilopoda were formerly associated with the Diplopoda. They differ, however, essentially from the Diplopoda, as well as from the Pauropoda and Symphyla, in the position of the generative orifices at the posterior extremity of the body, a character in which they agree with the Hexapoda or Insects. They are often swift-moving forms, and are carnivorous.

There are two sub-classes, Artiostigma and Anartiostigma.

Sub-class—ARTIOSTIGMA.

The tracheal tubes are retained in the Artiostigma, and their orifices open upon the pleural area of more or fewer of the segments. A dorsal plate (tergum) and a ventral plate (sternum) are present on each of the leg-bearing segments; and the number of ventral plates never exceeds that of the dorsal plates. There are four orders.

Order—Geophilomorpha.

Chilopoda in which the body is long and vermiform, consisting of a large number of somites varying, according to the genus, from about thirty-nine to over one hundred and forty. Each

Table-case No. 28.

somite, with the exception of the first and last, is furnished with a single pair of tracheal spiracles. The antennae are short, and consist of fourteen segments; eyes are always absent. The tergal plate of the segment bearing the toxicognaths is always distinct, generally large, and separates the head-shield from the tergal plate of the first leg-bearing segment.

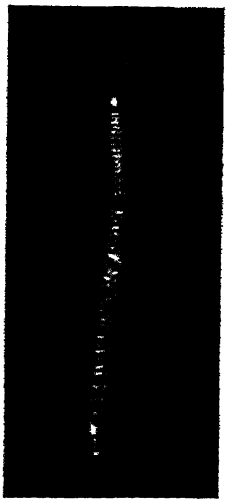


FIG. 88.
Geophilus longicornis
(slightly enlarged)

The young when hatched have the same number of segments as the adult. Like all centipedes, the Geophilomorpha have poison-glands, but their jaws are too weak to pierce the human skin. They live a subterranean existence, and their food consists almost entirely of earthworms. Two of the British species (*Linotaenia maritima* and *Schendyla submarina*), however, are marine in habit, and are found under stones between tide-marks. A number of Geophilids (including several British species, as *Linotaenia crassipes*, etc.) have been observed to exhibit the phenomenon of phosphorescence. The phosphorescent fluid which they emit possesses irritating properties, and is used for defensive purposes, and also, it is believed, as a means of sexual attraction.

Order—Scolopendromorpha.

Chilopoda, in which the body is of medium length, and bears, invariably, twenty-one or twenty-three pairs of legs. As a rule the stigmata are fewer than the legs, and are situated, roughly speaking, upon alternate segments. The antennae are longish, and never have fewer than seventeen, nor more than about thirty, segments. The tergal plate of the segment bearing the poison-jaws is suppressed, and the head-shield is in contact with the tergal plate of the first leg-bearing segment.

The young, which are generally, perhaps always, born alive, have the same number of segments as the adult.

Some of the tropical members of the Scolopendromorpha are of large size, and are much dreaded on account of their venomous bite. It is alleged, indeed, that the claws of the legs are poisonous to a small extent, and that when one of these animals crawls over the human skin, it leaves a track of inflammation behind it. Their

food consists of various insects, spiders, mice, or any living thing that they are able to overpower. The largest known centipede (*Scolopendra gigas*), which is an inhabitant of the West Indies and South America, sometimes reaches a length of almost a foot. The genus *Alipes*, which is confined to tropical Africa, is remarkable for the very peculiar structure of the posterior legs, which are modified to form a stridulatory organ, whereby the animal emits a hissing sound. *Ethmostigmus trigonopodus* is the largest and commonest of the tropical African species of centipedes, and it is also met with less frequently in the more temperate parts of Africa. Several of the species belonging to this order are very widely distributed, and two of them (*Scolopendra morsitans* and *S. subspinipes*), have been introduced, like the common rat or cockroach, into most of the seaport towns of the world, but, unlike these animals, they are unable to maintain themselves as far north as England This order includes only a single British member (*Cryptops hortensis*), which is not uncommon in gardens.

Table-case No 28.

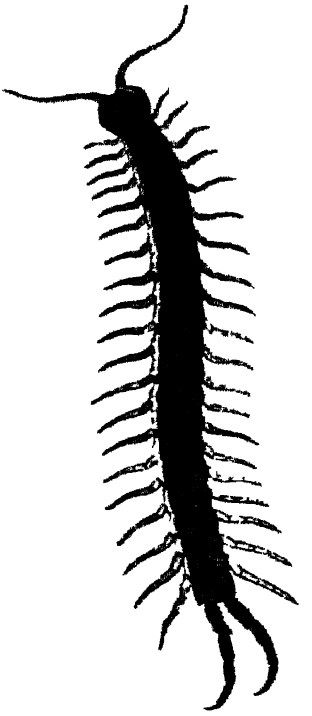


FIG 89

Scolopendra morsitans (after Koch).

Order—Craterostigmomorpha.

The dorsal plates number twenty-one in this order, but there are only fifteen pairs of legs, and the stigmata are reduced in number as in the Lithobiomorpha.

There is only a single species (*Craterostigmus tasmanianus*), which occurs in Tasmania.

Order—Lithobiomorpha.

Chilopoda in which the body is short and furnished with only fifteen pairs of legs, and six or seven pairs of stigmata arranged

Table-case No 28

approximately upon alternate segments, the terga without stigmata being greatly reduced in size.

The young, upon hatching, have only seven pairs of legs, the remaining eight being added with successive moults.

The Lithobiomorpha are swift-footed centipedes, which live under stones or fallen tree-trunks, and feed upon worms, insects, etc. They do not attain to any great size.

There are about half-a-dozen British species of *Lithobius*; perhaps the commonest of them is *Lithobius forficatus*.

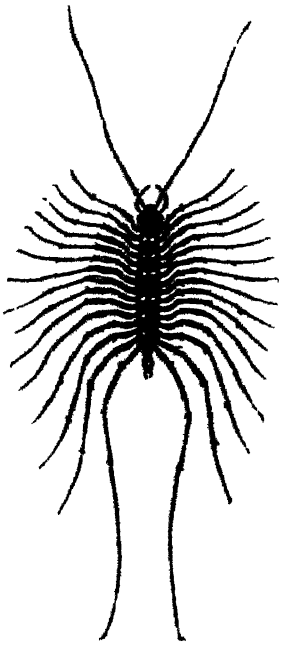


FIG. 90.

Scutigera (*Cermatia*) *forceps* (after Kingsley).

Sub-class ANARTIOSTIGMA.

The normal tracheal system is replaced in the Anartiostigma by a series of median dorsal pulmonary sacs, furnished with tubes dipping into the pericardial space, and opening each by a single stigma which results from the upward migration and coalescence of the normal pair of stigmata upon the first, third, fifth, eighth, tenth, twelfth, and fourteenth segments The remaining segments do not bear stigmata, and their dorsal plates are reduced or absent, that of the seventh disappearing completely. The antennae are very long and filiform; the legs, of which there are fifteen pairs, as in the Lithobiomorpha, are also very long, and have the terminal segments many-jointed.

The *Scutigeridae* (Fig. 90), the only family of the Sub-class, reach their greatest size in the tropics, and are quite unknown in north temperate and Arctic countries of the world. Most of the members of the order are of rather small size, but one or two of the Oriental species (*Scutigera longicornis*, etc.) reach a length of several inches. They live on insects, and are remarkable for their extreme swiftness of foot. They also have a habit, when pursued or seized, of dropping their legs. Hence it is exceedingly difficult to capture undamaged specimens.

INDEX

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GUIDE

TO THE

EXHIBITED SERIES OF INSECTS

IN THE DEPARTMENT OF ZOOLOGY

BRITISH MUSEUM (NATURAL HISTORY)

CROMWELL ROAD, LONDON, S.W.

(SECOND EDITION)

WITH 62 ILLUSTRATIONS

LONDON
PRINTED BY ORDER OF THE TRUSTEES
OF THE BRITISH MUSEUM
1909

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PREFACE.

As considerable time must necessarily elapse before the arrangement of the exhibited series of insects can be completed, it has been deemed advisable to issue the present provisional Guide. With one or two exceptions all the figures have been especially prepared for this work, and have been made from specimens in the Museum. The full-page illustrations are all from photographs of actual specimens exhibited in the Gallery.

To facilitate reference all the specimens have been numbered, except those under arrangement.

CHAS. O. WATERHOUSE.

January 27th, 1908.

PREFACE TO THE SECOND EDITION.

THE First Edition of this Guide, written by Mr. Chas. O. Waterhouse, being out of print, the author has revised it, with the help of his colleagues in the Insect Section, so as to bring the Second Edition as far as possible into line with the exhibited series of specimens. This has involved a considerable amount of extension; but the Guide must be regarded as provisional, since alterations are still in progress in the Gallery, the arrangement of which is far from complete.

SIDNEY F. HARMER,
Keeper of Zoology.

BRITISH MUSEUM (NATURAL HISTORY),
LONDON.
July, 1909.

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EXHIBITED SERIES OF INSECTS.

THE specimens of insects exhibited in the gallery are only a very small representative series. The main collection for the purpose of study is kept in cabinets in the Insect Room in the basement. It is estimated to contain 1,150,000 specimens, and comprises about 155,700 named species, occupying 13,000 drawers and 602 boxes.

The public gallery is only partially arranged.

The specimens are in table-cases placed down the centre of the gallery, numbered 29 to 56. The large specimens which are unsuitable for the table-cases are placed in the wall-cases at the sides of the gallery.

On each side of the gallery will be seen models (1–85) arranged on shelves, to illustrate the life histories of various insects. Where possible, species likely to be of interest from agricultural or horticultural points of view have been chosen. Nos. 11–21 are *Aphidæ* and other Homoptera. Attention is called to the three rose galls of *Rhodites eglanteriæ*, *nervosus* and *rosæ* (23, 25, 27). The reason why these three insects, which are so much alike that they require an expert to separate them, produce such different galls has never been satisfactorily explained. The series of galls made by Gall-flies (*Cynipidæ*, 29–47) is particularly deserving of careful attention. To understand the series of oak galls (29–43), it must be borne in mind that the males only exist in alternate generations, and that the females which appear in the same generation as the males are often so different from the females of the previous and following generations that until this fact was known the insects were placed in different genera. Hence there exists a double set of names for the same

species, and these are still used, but as a matter of convenience only. The common "oak-apple" (39) is a very good example. The males and females that come out of these are called *Andricus terminalis*. These females deposit their eggs on the roots of the oak, and produce small woody galls. From these root galls comes in the winter a much larger wingless insect, called *Biorhiza aptera*. These are all females. They crawl up the tree and deposit their eggs in the buds, which in the spring develop into the well-known oak-apples.

The marble gall (43) is still an enigma. The insects that come from these, *Cynips Kollari*, are all females. Although this insect is so common, the male has hitherto baffled all efforts to discover it.

Other galls of *Cynipidæ* are one on ground ivy formed by *Aulax glechomæ* (45), and a curious swelling in the stem of bramble formed by *Diastrophus rubi* (47).

On the east side of the gallery will be found models relating to Coleoptera (49–59), Hymenoptera (61–71), Lepidoptera (73–85), and Diptera (87). The larvæ of a great many Phytophagous beetles live on the under sides of leaves, eating the soft parts. The Mustard beetle, *Phædon cochleariæ* (49), sometimes attacks cultivated mustard with disastrous consequences, as the larvæ eat the flower buds as well as the leaves. Another model of great interest is one showing apple-buds injured by the Apple-blossom weevil, *Anthonomus pomorum* (53). The remarkable way in which certain weevils cut and roll leaves to form their nests is illustrated by *Attelabus* (57) on oak, and *Rhynchites* (59) on birch. The models relating to Hymenoptera include cherry injured by Slug-worm, *Blennocampa cerasi* (61); galls on willow formed by another saw-fly, *Nematus gallicola* (63); a third shows the gregarious habits of *Pamphilus flaviventris* (45); the way in which the Leaf-cutting Bee, *Megachile willughbiella* (71) forms its nest is shown by a single cell separated into pieces.

All the models relating to Lepidoptera (73–85) will repay study; perhaps the one that has received the most attention is the oak attacked by *Tortrix viridana* (77), the trees in the spring often being stripped of their leaves by this insect.

The British Insects (including the beautiful collection of Caterpillars of Butterflies and Moths, prepared by the Rt. Hon. Lord Walsingham) will be found in cabinets on the west side of the gallery.

The Foreign Insects are on the east side.

A large case on the east wall is devoted to a description of the external anatomy of insects. The series is not yet complete.

GENERAL ARRANGEMENT OF GALLERY.

Nests of Ants and Wasps.

Maps illustrating geographical distribution
Cabinet with British Insects

Models showing habits of
Gall-flies
Cabinets of British Lepidoptera.

Moth cocoons,
and
metamorphoses.

Froth-flies. Aphids. Cicadas. 56	Bugs. 55
53 Beetles.	54 Beetles.
Beetles. 52	Classification of Coleoptera. 51
49 Fleas. Midges. Gnats.	50 Flies.
Bees. 48	Hive Bees. 47
45 Ichneumons Galls. Ants.	46 Nests of Wasps
Saw-flies Classification of Hymenoptera. 44	43
41 Moths	42 Butterflies.
Moths 40	Moths 39
37 Dragonflies Caddis-flies.	38 Moths
May-flies Lacewings Dragonflies Antlions. 36	Stoneflies White Ants Alder-flies. 35
33 Cockroaches. Crickets	34 Locusts
Mantids Phasmas. 32	Earwigs Springtails. 31
29 Insects, introductory case.	30 Introductory series.

TABLE CASES.

Nests of Wasps and Bees.

Anatomical Case.
Cabinets of foreign Butterflies

Models showing habits of
Coleoptera and Hymenoptera.
Cabinets of foreign Insects.

Nests of
White Ants.

West Entrance.

East Entrance.

In arranging the gallery the intention has been to begin with the most primitive forms (which are nearest to the Centipedes and Millipedes in the next part of the gallery), and to proceed from these to the higher forms, or those most removed in their structure from the primitive type.

Scientific terms are avoided as much as possible ; but the names of the parts of an insect, having no English equivalents, are shown in a diagram of a Cockroach in the cover of the first table-case. The following words are also in use :—

APTEROUS.—Without wings.

JOINT.—This is applied to the *parts* or segments of the antennæ, palpi and tarsi.

METAMORPHOSES.—The changes undergone by an insect as it grows to maturity.

NEURATION.—The arrangement of the veins or nerves in the wings of an insect.

OVIPOSITOR.—The instrument used by the female insect in depositing eggs.

PUNCTURE.—A mark on a surface as if made with a pointed instrument.

GENICULATE.—Applied to the antennæ of an insect when they are bent at an angle in the middle ; elbowed.

The following diagram (fig. 1) shows the relationship which is believed to exist between the various Orders of insects.

The following is the sequence in which the Orders are placed in the cases :—

Aptera, Orthoptera, Neuroptera, Trichoptera, Lepidoptera, Hymenoptera, Diptera, Coleoptera, Rhynchota.

Class INSECTA.

(Table-cases 29–56.)

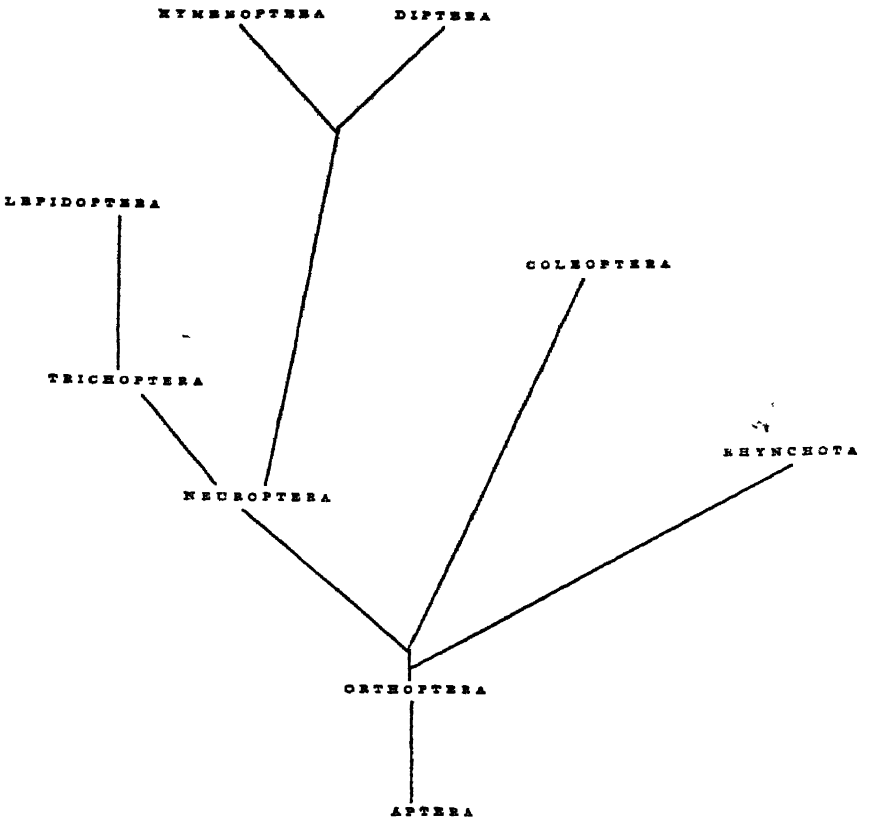
Table-case 29.

Insects are small animals whose bodies are divided into three regions, called respectively the head, thorax and abdomen. They breathe by means of *trachea* or air tubes distributed through the body, but opening externally by means of orifices, called *spiracles*, placed at the sides of the body. They have six legs, which are attached respectively to the three portions or segments of which the

thorax is composed. The head has two antennæ. The majority are provided with two pairs of wings, but some have only one pair, and many have none.

The nervous system consists of two parallel cords down the middle of the lower surface of the body, united at intervals by nerve centres called *ganglia*. From these nerves are sent off to the various

Fig. 1.



parts of the body. In insects of a most primitive type there is a *ganglion* in each segment of the body, but in the higher insects these ganglia are drawn more or less forward, often uniting, especially in the thorax.

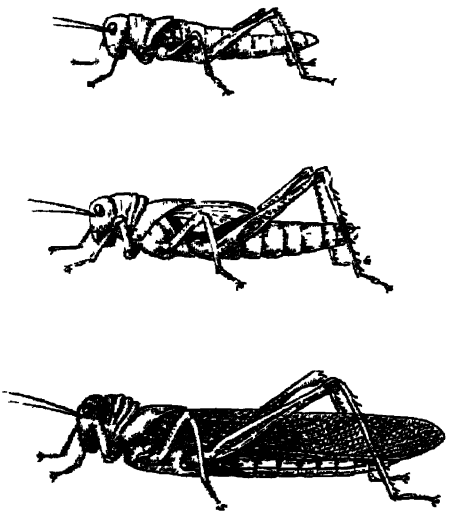
Examples of the caterpillar of a Goat-moth (1000), a Hornet (1002), Horse-fly (1004) and Summer Chafer (1006) are exhibited in Table-case 29.

Except in the lowest forms (the *Aptera*), insects undergo metamorphoses, *i.e.*, distinct changes as they grow to maturity. The stages are :—

1. The *egg*.
2. The *larva*. The insect as it leaves the egg ; the grub or caterpillar state.
3. The *pupa*. The stage immediately preceding the perfect state ; the chrysalis state.
4. The *imago*. The perfect insect.

Insects do not grow after they get to this state.
When the larva and pupa stages are nearly similar, and both

Fig. 2.



Larva, pupa and imago of a Brazilian locust, *Titanacris cristata* ; ½ nat. size. (125.)

more or less resemble the perfect insect, the word *nymph* is often used for both.

Table-case 29. Wall-case 8.

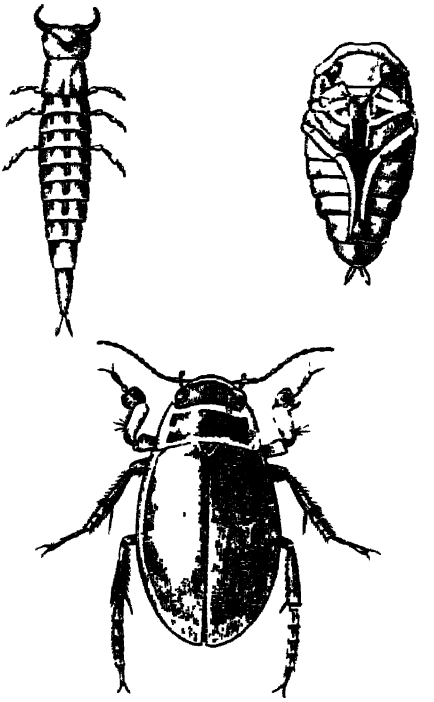
In some instances the changes are gradual, not very distinct, and the difference between the larva and perfect insect is slight. When this is the case the insect is said to undergo incomplete metamorphosis. Examples of a large Brazilian locust (*Titanacris cristata*, 125, fig. 2) are exhibited, also a *Eurycantha* (123), *Pseudophyllanax*

(127), as well as the Neuroptera *Æschna* (119), *Agrion* (121), and examples of large water-boatmen (145, 147).

In other cases the three stages are strongly marked (as, for example, the caterpillar and chrysalis of a moth). In such cases the insect is said to undergo complete metamorphosis.

Specimens of the larva, pupa and imago of a common water-

Fig. 3.



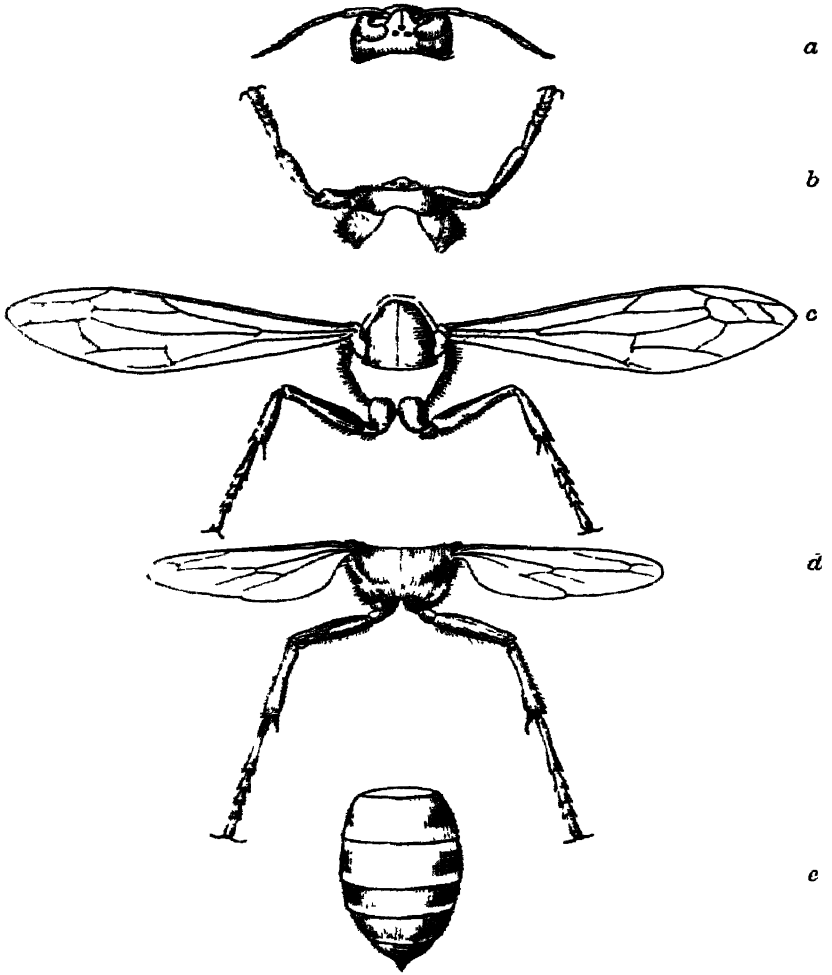
Larva, pupa and imago of a common English water-beetle, *Dytiscus marginalis*. (1010.)

beetle (*Dytiscus marginalis*, 1010, fig. 3) are shown in Table-case 29. Other examples of Coleoptera (129–143), of Neuroptera (111–117), of Lepidoptera (109), of Hymenoptera (101–105), and larvæ of Diptera (107) are shown in Wall-case 8.

In Table-case 30 is a series of insects showing examples of the different Orders, with labels indicating their principal characters. These are not arranged in a line, but (as far as can be) in accordance Table-case 30.

with their relationship as indicated in fig. 1, a copy of which is in the frame which forms the cover of the case.*

Fig. 4.



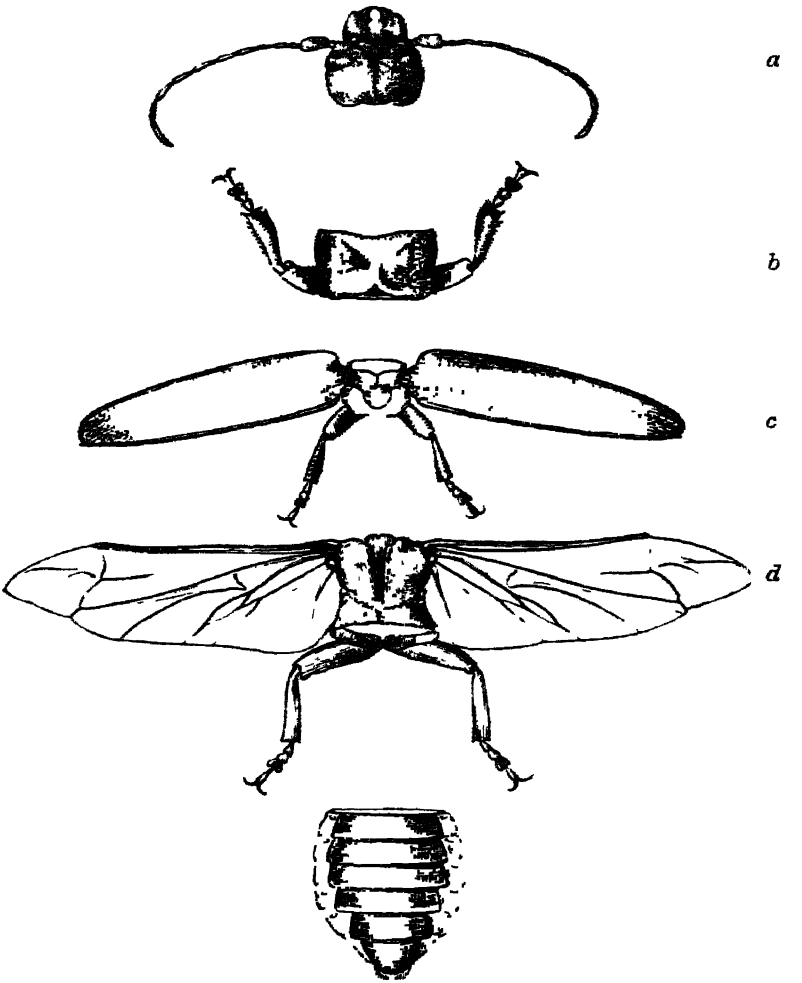
Hornet (*Vespa crabro*), dissected. (1015.)
a, head; *b*, prothorax *c*. mesothorax; *d*, metathorax; *e*, abdomen.

The body of an insect is divided into three principal parts,

* As insects fade when exposed to the light, many losing their colours in a few months only, it is necessary to protect them from the light as much as possible. The glazed frames which form the covers should be raised and allowed to rest against the support on the top of the case, and be lowered again when done with.

namely, the head, thorax and abdomen, as shown in the diagram of a Cockroach in the cover of Case 1. The head bears a pair of

Fig. 5.



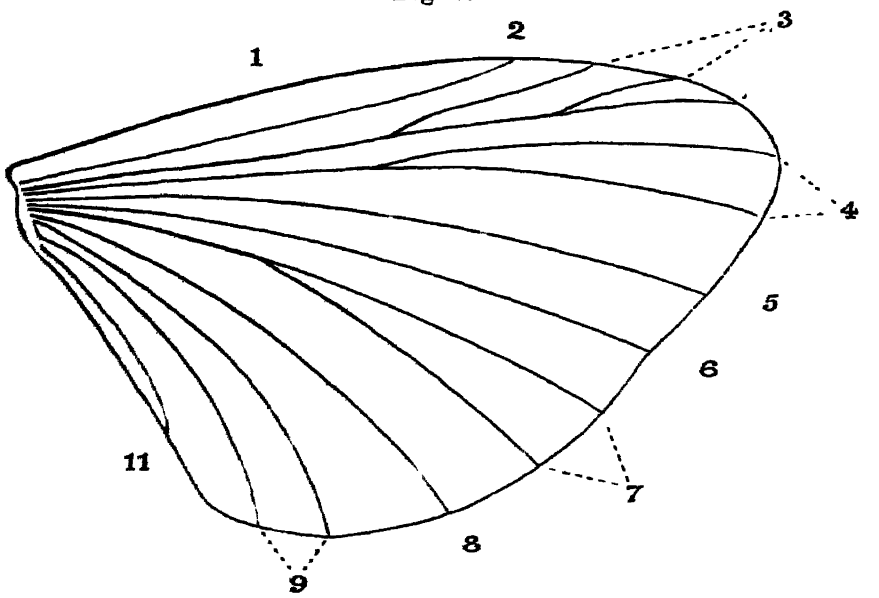
Beetle (*Brecephilydia jejunum*), dissected. (1016.)

a, head; *b*, prothorax; *c*, mesothorax; *d*, metathorax; *e*, abdomen.

organs called antennæ, and has two "compound" eyes. It is sometimes imbedded in the thorax as in grasshoppers, beetles, etc.; in other cases it is free, being only attached to the thorax by a membranous neck, as in flies, wasps, etc.

The thorax is composed of three segments called respectively prothorax, mesothorax and metathorax. The relative sizes of these three parts vary greatly, and furnish important characters for purposes of classification. In some it is the prothorax that is greatly developed (as in beetles), but in others it is the mesothorax that is the largest (as in flies, bees, etc.). The prothorax bears the front pair of legs. The mesothorax bears the front pair of wings and the second pair of legs, and the metathorax bears the second pair of wings and the hind pair of legs. Speci-

Fig. C.



Theoretic diagram of wing.

mens dissected (1015, 1016) to show this are exhibited in Table-case No. 29.

The abdomen generally consists of nine visible rings or segments, but occasionally there are ten, and the number is often less; the reduction in the number is due, either to the basal segments becoming membranous and so disappearing, or to the apical segments having been modified and withdrawn into the body. The last segment often bears a pair of jointed organs called *cerci*.

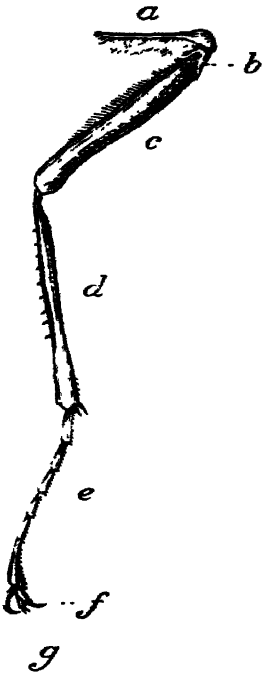
In the wings are seen a number of horny rib-like lines, usually called veins, in which the tracheal tubes run. There are nine principal veins, but these often send off branches, especially towards

the margin of the wing. Besides these veins there are cross-veins, sometimes few in number, in other cases very numerous so that (as in the Dragon-flies) the wing has the appearance of network. To avoid confusion these cross-veins are called nervures.

In the classification of insects the way in which the veins are arranged is of great importance. The principal veins have received various names, but as it is, or was, impossible to ascertain the corresponding veins in the different Orders, each author has used the names that best suited his purpose. The names most commonly in use are given in the anatomical case at the end of the gallery. In the diagrams in the table-cases the veins are only numbered and coloured, those that are believed to be homologous being similarly coloured throughout.

The eyes are of two kinds; simple and compound. The simple eyes, called *ocelli*, are placed on the front or upper part of the head; three is the most usual number, but some insects have only two, and a few only one. They have the appearance of glass beads imbedded in the surface of the head. The compound eyes are placed at the sides of the head. They are termed compound because they consist of a number of lenses, varying from seven to twenty-seven thousands. In some insects these lenses are placed close together but retain their round form; in others they have the appearance of having been pressed together, so that each lens is six-sided (hexagonal) and the whole eye presents the appearance of a honeycomb.

Fig. 7.



Leg of a beetle (*Chiasognathus*). (1020) *a*, coxa, *b*, trochanter; *c*, femur; *d*, tibia; *e*, tarsus; *f*, claw; *g*, onychium (enlarged).

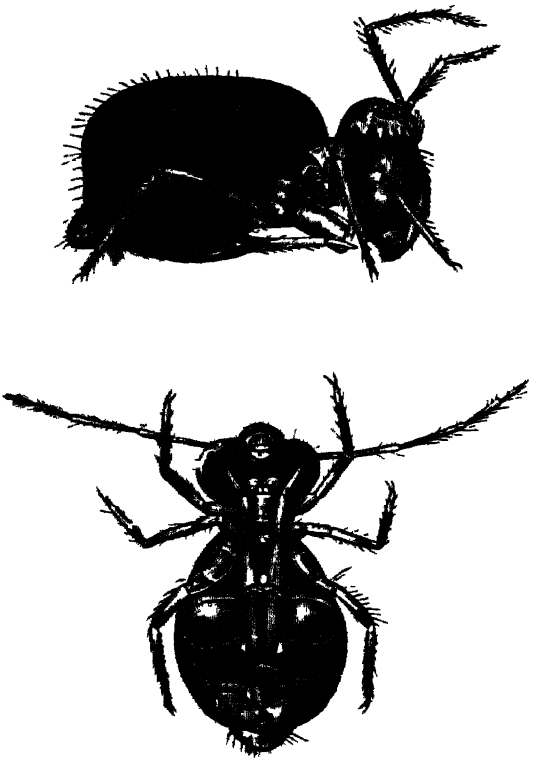
The legs (1020) are composed of five principal parts: 1, the coxa, which fits into a sucket in the body; 2, the trochanter, which in some cases is divided into two; 3, the femur; 4, the tibia; 5, the tarsus, which normally consists of five joints, but the number is sometimes four or three, and in exceptional cases two or even one. The last joint is provided with a pair of claws, and between these there is often a small piece, which has received various names, such as *pulvillus*, *arolium*, *onychium*, according to its form.

Order APTERA.

Table-case 31.

In Table-case 31 are exhibited examples of the *Aptera*, which include the Springtails and Fish Insects, and are wingless insects which undergo no metamorphoses, the young resembling the adult

Fig. 8.



Springtail (*Papirius*), greatly enlarged (after Lubbock).

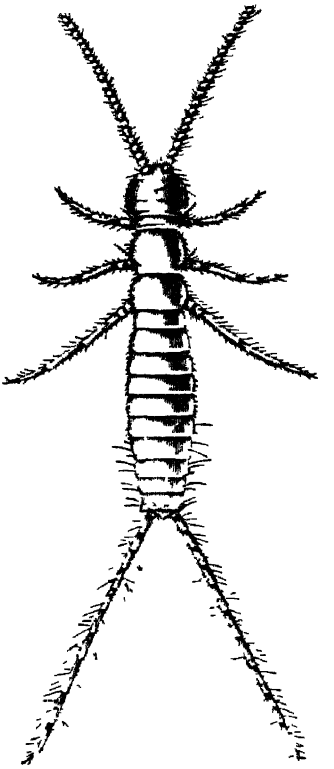
except in size. They are usually divided into two sub-orders, *Collembola* and *Thysanura*.

The *Collembola*, or Springtails, are small soft-bodied insects, very common in decaying vegetable matter, on herbage by the roadside, on the banks of ponds, and on the surface of stagnant water. One small white species (*Isotoma fimetaria*) can live equally well on land and on the top of water, and as it can live under water for many weeks it has at times caused some trouble by getting into cisterns.

Many of the species are clothed with scales very similar in appearance to the scales on the wings of butterflies.

Their name of Springtail is derived from the fact that many of them possess the power of leaping by means of an appendage lying beneath the body. The lower figure in the illustration (fig. 8) shows

Fig. 9.



Campodea staphylinus, enlarged seven times.

this forked appendage. Some of the genera do not possess this power.

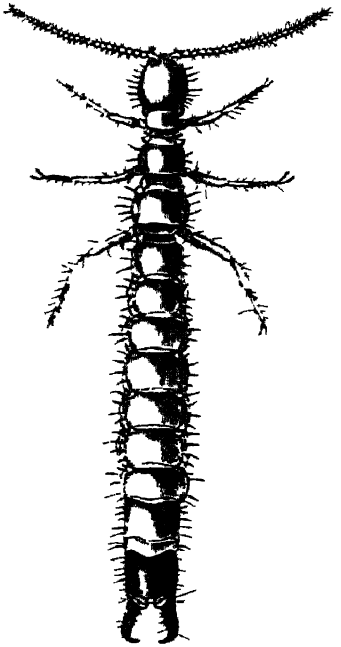
The *Thysanura* are divided into four families: *Campodeidæ*, *Japygidæ*, *Machilidæ*, and *Lepismidæ*, insects which differ greatly in appearance and structure.

The first includes what is perhaps the most primitive of all insects —*Campodea*, a small, nearly white, very active creature, about a quarter of an inch in length, common in garden mould, under dead leaves, etc.

Table-case 31.

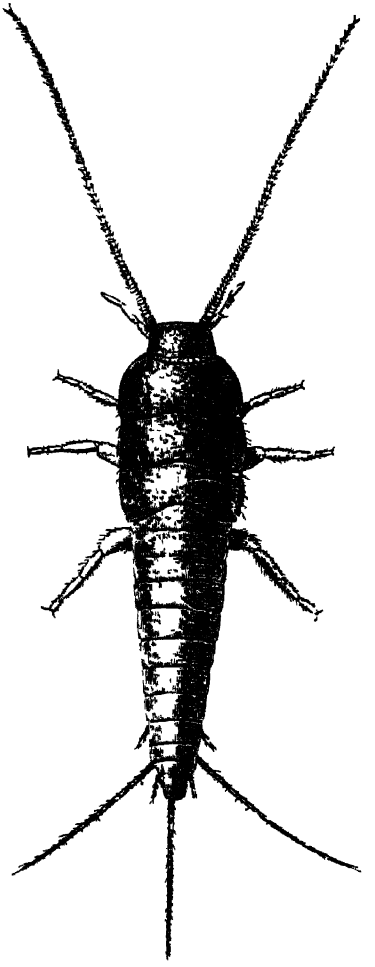
Japyx (1042) somewhat resembles *Campodea*, but the cerci, instead of being long, many-jointed organs, are modified into short strong

Fig. 10.



Japyx solifugus, enlarged nine times.

Fig. 11.



Fish Insect, *Lepisma saccharina*, enlarged six times (after Lubbock). (1050.)

forceps, somewhat as in the Earwigs. There are several species, one being S. European.

Another and much better known member of this sub-order is *Lepisma saccharina* (1050), the Fish Insect. It is about half an

inch long and when in perfect condition is clothed with silvery-grey scales. It is common in warehouses, clothes presses, and sometimes does considerable mischief to old prints, books, etc., by gnawing away the surface.

An allied insect is *Thermophila furnorum*, of which a drawing is exhibited. It is about half-an-inch in length, of a yellowish cream colour, prettily ornamented with grey and black scales. It is not often seen, but occasionally occurs in great numbers in London bakeries, hence its name "Baker's Brat."

Order ORTHOPTERA.

In the second half of Case No. 31 the series of *Orthoptera* commences. These are divided into seven families. the principal characters of which are as follows :—

A. Orthoptera Cursoria — Hind legs formed for running or walking	Legs attached to the side of the body by small coxæ. (Fig 12).	Tarsi 3-jointed.	Forficulidæ (Earwigs).
		Tarsi 5-jointed.	Phasmidæ (Stick Insects)
	Legs with large, elongate coxæ. (Fig 13).	Front legs formed for seizing.	Mantidæ (Mantids).
		All the legs formed for running.	Blattidæ (Cockroaches)
B. Orthoptera Saltatoria. — Hind legs formed for leaping.	Antennæ long, thread-like	Tarsi 3-jointed.	Gryllidæ. (Crickets).
		Tarsi 4-jointed.	Phasgonuridæ (Long-horned Locusts).
	Antennæ not very long.		Locustidæ. (Locusts and Grasshoppers).

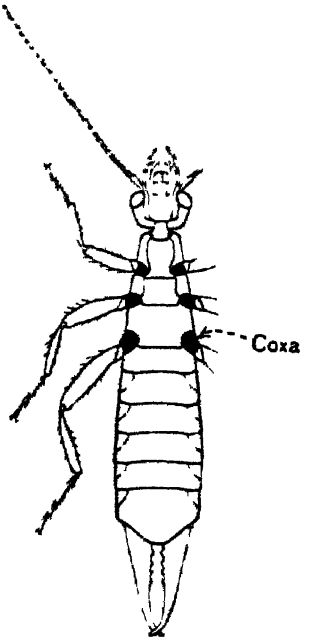
Family Hemimeridæ.

An insect of particular interest in this case is *Hemimerus* (1056), a wingless insect found on a rat or "ground pig" (*Cricetomys gambianus*) and other small mammals in Africa.

1 Table-case 31.

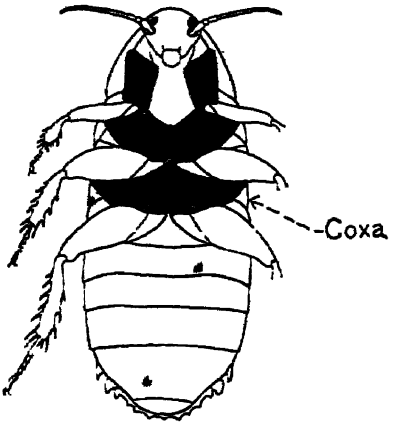
Like most other parasites it is difficult to determine where it should be located in a natural system, and it is therefore placed

Fig. 12.



Under side of an earwig (1077.)

Fig. 13.



Under side of a cockroach. (1080.)
The coxæ are shaded black.

here immediately after the *Thysanura* and at the head of the *Orthoptera*. It was originally described as allied to the *Gryllidæ* (crickets).

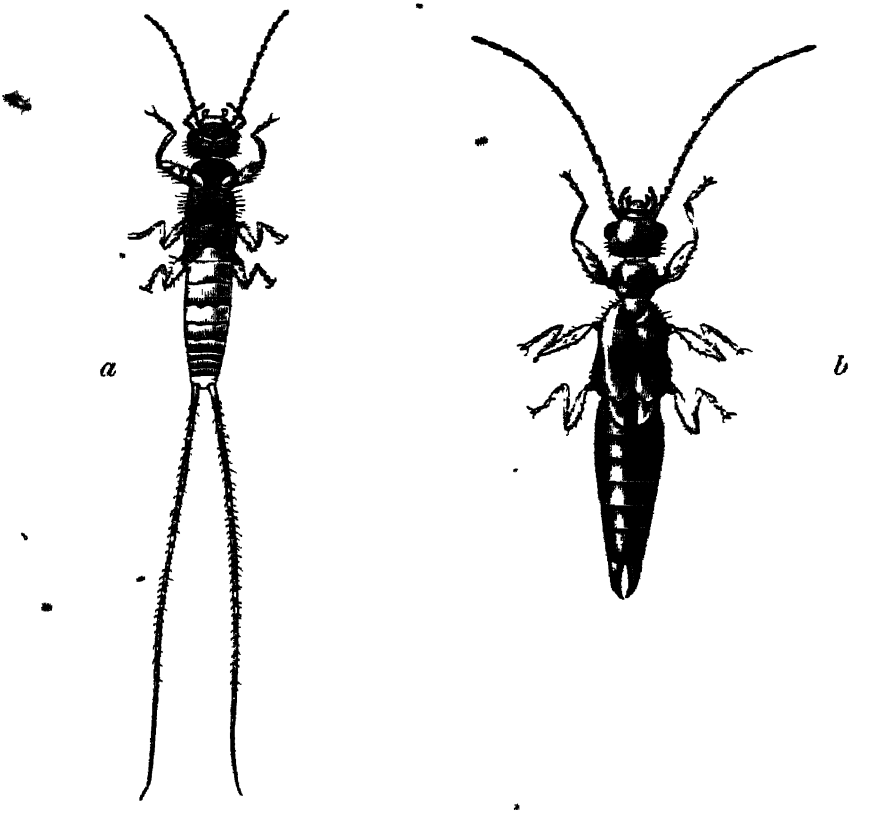
Family FORFICULIDÆ.

Following this are the earwigs, *Forficulidæ* (1060–1069). Of this family there are many hundreds of species, and they are found all over the world; two are common in Britain, *Forficula auricularia* (1067) and *Labia minor* (1065), the smaller of these, however, is not often seen as it is chiefly found in manure heaps. One of the chief characteristics of this family is the pair of forceps at the end of the body. The shape of these varies very much, and they are smaller in the female than in the male. They are modifications of the cerci. In the common British and many other species the insect leaves the egg with the forceps already to some extent formed,

the jointed character of the cerci can, however, be seen while the insect is still in the egg (fig. 15).

In *Diplatys* (1060) from Ceylon, and perhaps in other exotic species, the larva leaves the egg with the cerci of great length (fig. 14, *a*), and these continue until the skin is cast for the last

Fig. 14.



a, Larva, and, *b*, imago of an Earwig, *Diplatys longisetosa*, enlarged six times. (1060.)

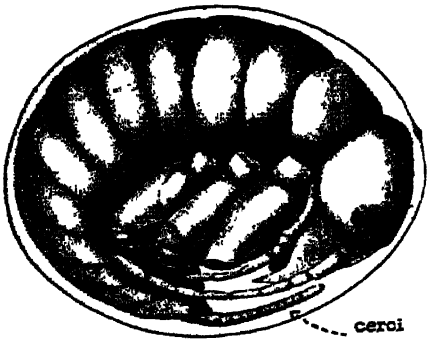
time, when the cerci are thrown off and the forceps (which have now formed within them) appear (fig. 14, *b*).

Many earwigs have no wings, but in the majority the front pair are modified into elytra of a leathery texture, with a straight suture, and not or scarcely overlapping. The hind wings are ample, but when at rest are folded beneath the elytra. Both in the way they

Table-case 31.

are folded and in the character of the neuration they are quite unlike those of any other insect.

Fig. 15.



Egg of common earwig, *Forficula auricularia*, greatly enlarged.

The eggs are spherical, leathery, semitransparent. They are deposited separately in small groups in the earth.

Family PHASMIDÆ.

Table-cases 31, 32.

These insects (1070–1096) are remarkable for their resemblance to twigs, sticks, leaves, &c., whence their popular name Stick-insects. Many of the species, such as *Diapheromera* (1081) for example, are wingless in both sexes. In some cases the male has wings, the female none; in *Acrophylla* (1092) and allied species both sexes have ample wings. *Aschiphasma* (1086) is one of the very rare instances in which the front wings are entirely absent, the hind wings being fully developed. The species of *Phyllium* (1094) are remarkable for their resemblance to leaves—this is especially the case in the female. The male has delicate transparent hind wings. The female has no hind wings, but the front ones are considerably developed, and the arrangement of the veins gives them a very leaf-like appearance. It should be observed that this wing consists almost entirely of the part in front of the chief veins, the hinder part (that generally developed in other insects) is reduced to a narrow strip. The male has long antennæ; in the female they are very short.

The eggs of *Phasmidæ* are very remarkable. Some are vase-shaped, others resemble seeds. They are very diverse in form, and even in closely related species such as *Phyllium siccifolium* and

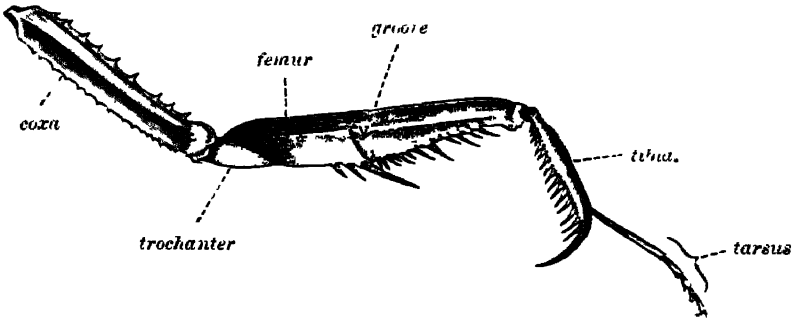
P. pulchrifolium they are quite different. Some examples of the eggs are exhibited (1092, 1094), and enlarged drawings of several are shown in the table cover. As if to complete the resemblance to seeds many of them have a mark on one side resembling the point of attachment, "*hilum*," of beans, etc. When the young insect comes out of the egg, the top is pushed off like a lid. Table-case 32.

The *Phasmidæ* are vegetable feeders, living on grasses, shrubs and trees, where their curious forms enable them to rest concealed.

Family MANTIDÆ.

In the second half of table-case No. 32 are a few examples of Mantids. They are carnivorous, feeding chiefly on other insects. They are found in Southern Europe and are common in tropical countries. The European "Praying Mantis" (fig. 16, 1128), derives its name from the habit (common to all the species) of standing on its four hind legs, with the front pair held up and close together. In this attitude they remain until some fly or other insect comes within reach, when the front legs are darted out with lightning rapidity and

Fig. 18.



Leg of a Mantis.

the fly is caught between the spines on the tibiæ and femora. This curious structure of the front legs (fig. 18) is the chief character of this family. It will be noted that the front coxæ are very long, which enables the leg to be thrown forwards. There is a row of spines on the under side of the tibia, and these when the tibia is folded against the femur fit between the spines on the latter, the terminal curved spur resting in a groove on the inner side of the femur.

The colours and curious forms of many of the species are well

calculated to render them inconspicuous, when waiting among leaves either living or dry; or on the bark of a tree as *Acanthops* does (1137). Some species have bright colours beneath, and at a distance this gives the appearance of a flower which may attract insects. *Idolum diabolicum* (1143) from E. Africa is a good example of this. The colours fade after death, but a plate from the Proceedings of the Cambridge Philosophical Society is exhibited to show the natural colours.

The eggs of *Mantidæ* are laid in a regular manner in flask-shaped receptacles or egg-sacks, each sack containing several eggs. The sacks are arranged one against the other, alternately right and left, the whole series being enclosed in a capsule or envelope (fig. 17A). These capsules have the appearance of being formed of gelatinous matter. They are sometimes compact and hard, sometimes semitransparent and smooth. Usually the capsule has along the upper side a ridge in which may be seen a number of small holes or slits (fig. 17B). These are the openings of the sacks by which the young escape; they are not always visible. The transparent capsules (1152) have the egg-sacks suspended by the sacks' necks. The capsules are always attached to some object, such as a stone, twig, or stem of grass.

Family Blattidæ.

In Table-case 33 are examples of the Cockroaches, *Blattidæ* (1170–1193). One of the chief characteristics of this family is the great development of the coxæ, which occupy nearly the whole of the sternal region. The legs are densely spined. The wings when present are ample, the front pair are leathery and serve as covers for the hind pair. The curve taken by the sixth vein, cutting off all the basal part of the front wing, is a peculiarity only seen in this family. Many species are without wings in both sexes. The female of the common house Cockroach, or "black-beetle" (1177), has no wings, and the females of *Heterogamia ægyptiaca* (1175) (where the differences in the sexes are very great) and of many other species are also wingless. The brown Ship-cockroach, *Periplaneta americana* (1178), is winged in both sexes; in the female, however, they are rather shorter than in the male. An interesting series of this species (1193) is exhibited to show the curious attitudes of the insect when cleaning itself. The antennæ are drawn down by means of the front leg and then passed through the mouth to remove all dust. One specimen has turned its head so as to clean the hind angles of

Fig. 16.

SIDE VIEW OF COMMON EUROPEAN MANTIS (1128).
(*Mantis religiosa.*)
(Photographed from a specimen in the Museum

A

Fig. 17.

B

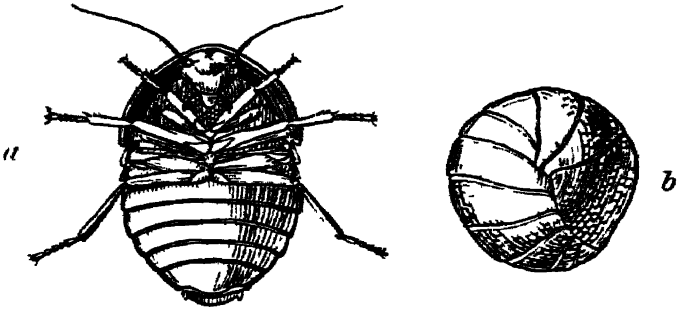
DIAGRAMS SHOWING THE STRUCTURE OF THE EGG-SACK OF A MANTIS.

[*To face p.* 20.

its thorax. One is seen cleaning its under side; another its hind leg. These are all set as they were seen in life.

Another common species is *Phyllodroma germanica* (1172). This insect appears to belong more to Northern Europe. It was rarely met with in England until comparatively recently, but has spread rapidly in London and is now a great pest. There are three British cockroaches which are found in woods and among furze bushes or heaths. These are all small species. Some of the species found in the tropics are of considerable size, especially those of the genus *Blabera* (1186) and *Megaloblatta* (1173), some of which measure nearly six inches in expanse of the wings. Some species bear a close resemblance to Coleoptera. *Phoraspis picta* (1174) and *Corydia*

Fig. 19.



Perisphœria glomeriformis, twice natural size. (1189.)
a, underside; *b*, side view when rolled

petiveriana (1190) are good mimics of Tortoise-beetles. *Prosoplecta coccinella* resembles a Ladybird (*see* drawing).

Perisphœria (1189) can roll itself up into a ball (after the manner of an Armadillo, or wood-louse); the end segment of the body fits exactly into the front of the prothorax, so that the head and legs are completely hidden and protected (fig. 19).

Female Cockroaches may often be found carrying their eggs in a capsule at the end of the body. The eggs are arranged in this capsule in two rows, upright like sacks, alternately right and left, with a single one at each end, the whole being covered with secretion which hardens into a leathery substance (*see* drawing). The structure is very similar to that of the egg-mass of the *Mantidæ*, but in those each sack contains several eggs; in the *Blattidæ* each sack contains but one egg. The number of eggs in the whole capsule varies.

Panesthia javanica (1192) appears to be viviparous, as the

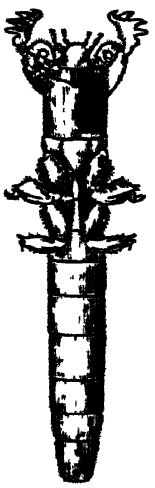
Table-case 33. young are seen to be nearly fully developed in the body of the female exhibited in the case, but whether these leave the body in an active condition or not is still uncertain.

Family GRYLLIDÆ.

The jumping Orthoptera (*Saltatoria*) begin in the second half of this case. The first family is the *Gryllidæ*, or Crickets (1201–1212). These are characterised by their long thread-like antennæ; and tarsi composed of three joints only. A few species have only two joints. The tarsi are hairy or spiny beneath, not provided with soft pads as in the following family. The basal joint is very long, and is nearly always furnished with a spine at each apical angle, the one on the inner side being much longer than the other. The species are nearly all of a brownish or horn colour.

The chirping of the common house Cricket and other Crickets is caused by rubbing one wing over the other. The males only produce this sound. The wings are nearly alike, and the right one is generally, but not always, uppermost. The veins are much contorted so as to produce a more or less drum-like space in the wing. One vein is file-like on the under side, and this plays like a bow on a raised part of the margin of the drum and causes the well-known sound (1209, 1213). In the male *Harpinus* flight is sacrificed to this power of producing sound, the hind wings are absent, and the front pair are converted into a drum.

Fig. 20.



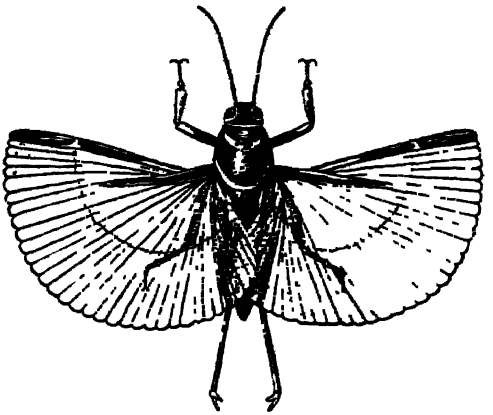
Cylindrodes Kochii.

Most of the species burrow in the ground, or live under stones or in caves. *Nemeobius sylvestris*, found in the New Forest and in woods, lives among dead leaves. The Mole-cricket (*Gryllotalpa*, 1201) has the front legs specially adapted for burrowing. The tibia, which is very short, has prong-like projections below, the spurs are long, and the lower angle of the first and second joints of the tarsi are produced and thus form part of the burrowing apparatus. *Cylindrodes* (fig. 20) has a somewhat similar apparatus, but it is formed in a totally different manner. The prong-like projections are part of the *upper* edge of the tibia; the spurs are absent; and the tarsus, which is simple and too delicate to assist in burrowing, lies back on the inner side of the tibia, where it is protected.

Species of *Gryllotalpa* are found in Europe (including England), Asia, Africa and Australia. *Cylindrodes* is found in Australia, and is said to live in the stems of a plant. It is quite smooth and of a yellowish colour.

A remarkable insect of this family is *Tridactyla*, a genus found in Europe, India, Africa and America. The hind tarsus is absent, and in its place are four curiously-formed spurs, which are hooked

Fig. 21.



Rhipipteryx limbatus, enlarged three times (1203.)

and toothed at the end; one of these is directed upwards and inwards. A closely allied insect is *Rhipipteryx* (fig. 21, 1203). This has only ten joints to the antennæ, which in the *Grylludæ* are usually very long and slender, and the wings are unlike those of any other insect. The front margin is leathery; the rest of the wing is fan-like, entirely without cross nervures, and when at rest is folded under the leathery front margin.

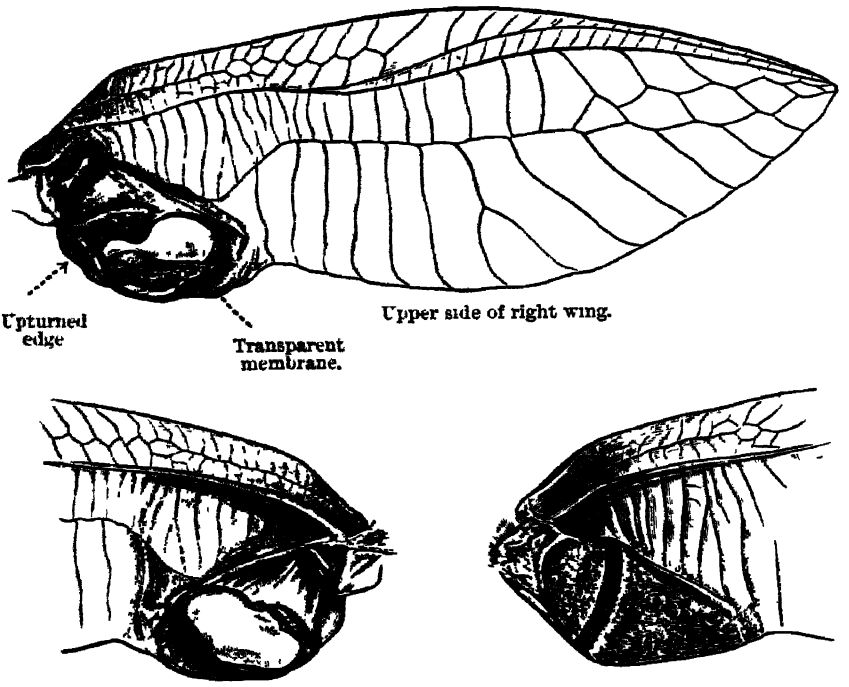
Family PHASGONURIDÆ.

The Long-horned Locusts, *Phasgonuridæ* (1241–1254), differ from the *Gryllidæ* in having four joints to their tarsi. The first three joints are of about equal length, furnished beneath with soft fleshy pads which enable them to hold on to leaves and stems of plants. The antennæ are of great length and very slender, consisting of a large number of joints; 480 have been counted in the antennæ of *Meroncidius*. Table-case 34.

Table-case 34.

They live on trees and shrubs, feeding on leaves, but many species eat caterpillars. The wings of many species in their form and coloration closely resemble dead or living leaves. Species of *Pterochroa* (1252) have the front wing leaf-shaped, marked with blotches as if injured by insects or fungi, and the edge has the appearance of having been eaten by a caterpillar. Some allied

Fig. 22.



Wings of a Long-horned Locust (*Macrolyristes imperator*), slightly less than natural size.

genera (*Mimetica*, etc.) closely resemble dead leaves. Many kinds are wingless, such as *Hetrodes* (1245), and many others that live in caves. The males of some of these (*Anastostoma* and *Mimnermus*, for example) have very large heads, and have the jaws greatly developed. These are probably used for fighting. The males of *Gryllacris* (1244), allied winged insects, fight each other furiously, their wings being extended and held erect while doing so.

Fig. 24.

PHOTOGRAPH OF A SMALL PORTION OF A SWARM OF LOCUSTS. (*Acridium peregrinum.*) SHOWING A METHOD OF TRAPPING THEM. $\frac{1}{14}$ NAT. SIZE.

[*To face p.* 24.

The males of the majority of the winged species produce a chirping sound. This is produced in the same way as in the Crickets, but the drum is at the base of the wing, and is more developed in the right wing; the left wing bears the file or bow and is always uppermost (fig. 22). In *Ephippiger* and a few allied genera both sexes are provided with a sounding apparatus.

A large number of species in this family have an auditory apparatus or ear at the base of the front tibiæ. The tibia at this point is somewhat enlarged, and on each side there is an oval impression, of a complex structure formed to receive sounds. In some species there is only a narrow slit instead of the oval impression. Both sexes possess this apparatus.

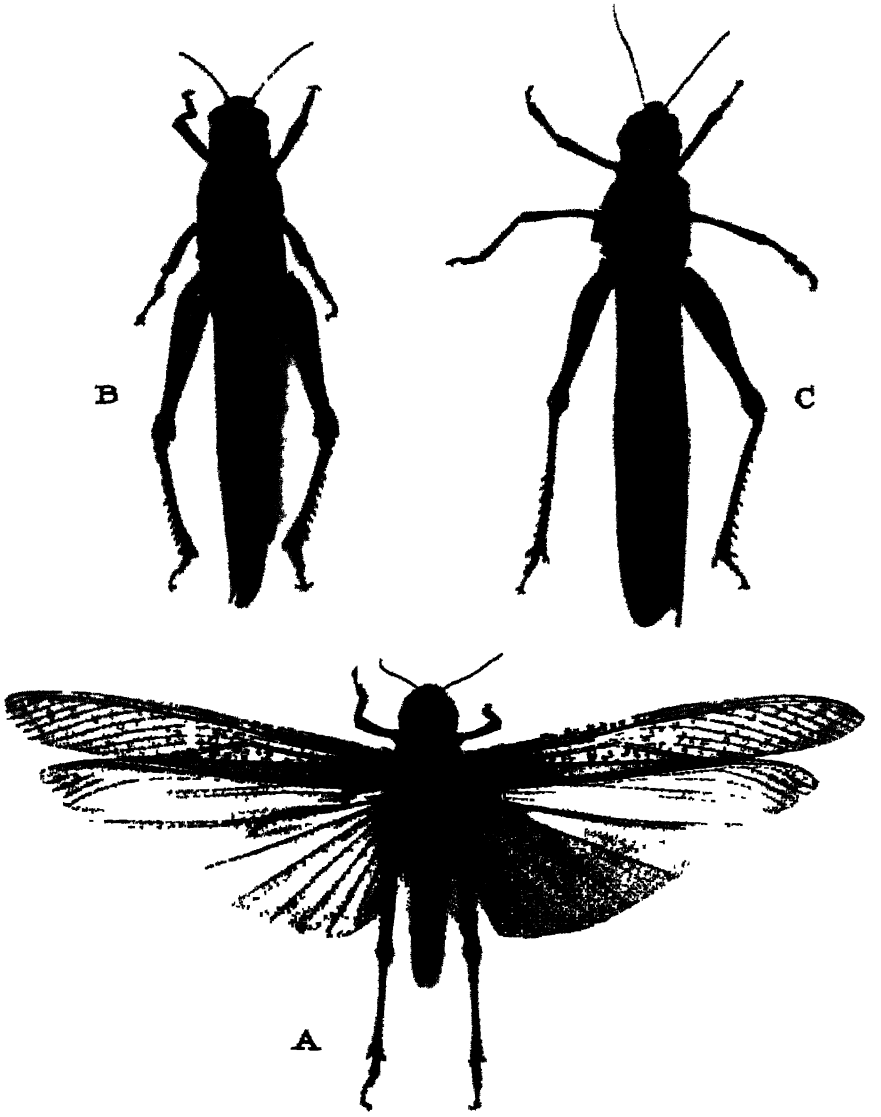
A curious Indian insect (*Schizodactylus monstrosus*, 1243), exhibited in this case, deserves special notice. It is remarkable for the great length of the wings, which, when at rest, are coiled at the tip like a watch-spring. The tarsi are also unlike those of any other insect. They have four joints, the first and fourth are long, the second and third very short, and have on each side a broad and flattened lobe, in addition to which in the posterior pair the basal joint is expanded on each side into a triangular plate. This insect burrows to a considerable depth in the banks of rivers, remaining under ground during the day and flying by night. Some authors have placed this insect in the family *Gryllidæ* on account of its general form and burrowing habits, and on account of the absence of the ear-like impression on the front tibiæ. The tarsi are, however, four-jointed as in the *Phasgonuridæ*.

Family Locustidæ.

The next case contains the Grasshoppers and Locusts, *Locustidæ* (*Acridiidæ* of many authors, 1271–1295). These differ from the five preceding families in having short antennæ. The tarsi have three joints, the basal ones being provided with soft pads beneath. A few species are wingless, or nearly so. In the species which have the wings fully developed, the front pair are of a firmer texture than the hind pair and serve as coverings for them; they are generally longer than the posterior pair. Table-case 34.

The front legs are not provided with an ear as in the *Phasgonuridæ*, but a somewhat similar organ is found on each side of the base of the abdomen. The chirping of grasshoppers is not produced by the wings, but by rubbing the femur against the wing. If the hind

Fig. 25.



MIGRATORY LOCUSTS.

A. *Pachytylus migratorius.* B. *Acridium ægyptium.* C. *Acridium peregrinum.*

(All slightly reduced.)

(Photographed from specimens in the Museum.)

[*To face p.* 26

The extent to which these species are migratory, and the height at which they fly vary according to the species and circumstances. *Acridium peregrinum* travels for some hundreds of miles; and swarms, probably of this species, have been met with a thousand miles out at sea. Their breeding places are generally dry and rather elevated plains. Their eggs are laid in the ground, in cylindrical masses, coated with earth. The swarms are often followed by birds, which devour large numbers of them. The grubs of flies of the genus *Bombilius* (or its allies), and those of certain Blister-beetles live on their eggs.

Some photographs are exhibited taken of a swarm of *Acridium peregrinum* which occurred in Algeria, showing the methods taken for entrapping them (fig. 24). The foreground of one of these shows the remains of what was a cornfield. The barrier is made of canvas, with a strip of American leather at the top, which being smooth does not give the locusts a good footing. At intervals the men shake the locusts off, and they are buried in trenches.

The species which are occasionally found in Britain are *Pachytylus migratorius*, *P. cinerascens* and *Acridium peregrinum*. *Acridium aegyptium* (1293) has since 1898 been frequently found in and around London, having been imported in vegetables (fig. 25B).

Order NEUROPTERA.

Sub-order ISOPTERA.

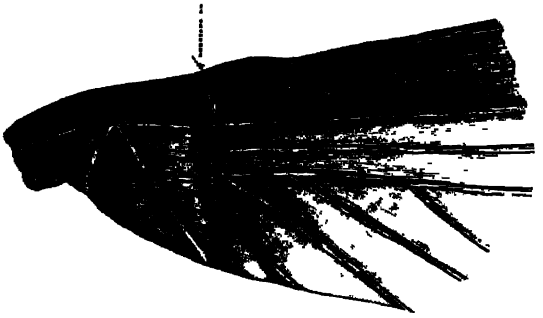
This case contains the commencement of the Neuropterous series, the *Isoptera*, White-ants or Termites (1300–1310). The metamorphosis is gradual, incomplete. In some individuals there is merely a difference in size between the young and the adult. The wings, when present, are four, folded flat on the back when at rest; the front and hind pairs are very similar in size and neuration, which is of very simple character; the distribution of the veins is, however, strangely dissimilar in different genera. Near the base of each wing there is a cross line where the wings are easily broken off, the basal parts remaining as horny flaps on the insect's back (fig. 26). The tarsi have four joints. Table-case 35.

The forms usually met with in a "Termitarium," *i.e.* a community of Termites, are soldiers and workers without wings in all their stages; and special sexual forms which have wings when adult.

Table-case 35.

These forms are undistinguishable when they first leave the eggs, but soon show more or less of the character of the form which they will ultimately become. It seems, however, that Termites have some power of modifying or checking the development of individuals so that some females of the special sexual forms do not develop wings, and are held in reserve in case any accident should happen to

Fig. 26.



Base of a Termite's wing showing the line where the wing breaks off.

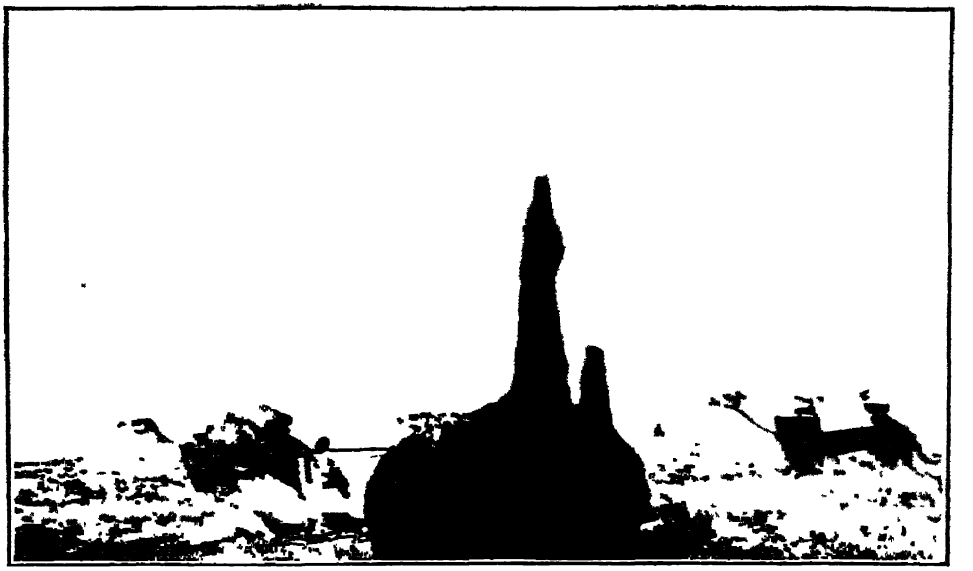
the "Queen" upon which the existence of the community depends. These individuals have been called "complementary reserve queens," and when actually substituted for a queen "substitution queens."

The special sexual forms above alluded to are so called because it is upon these that the continuance of the species appears to depend. Individuals of both sexes are found among soldiers and workers, but it is highly improbable that they ever reproduce their species. The males and females that have wings throw them off soon after leaving the nest in which they have been reared, and in some cases become kings and queens of new colonies. But from the enormous size to which some of their nests grow it seems probable that these kings and queens may continue with the original colony.

Wall-cases 9 & 10.

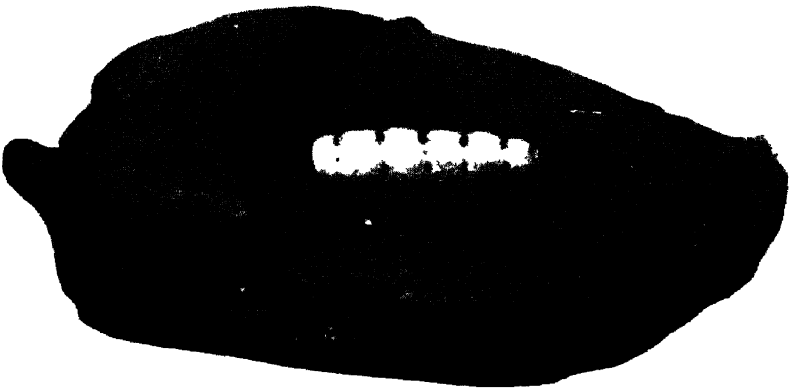
In their mode of life they much resemble the true ants, which are Hymenoptera. They live in large colonies. Their nests are very various in form. Some species (*Eutermes* for example, 173) build nests in trees, but in this case it seems probable that the nest is connected by covered ways with an underground nest. Other species which have their nests underground, build nests above the ground, sometimes of curious shapes, the very large ones being three to ten feet or more in height (fig. 28). The greater part of the nest

Fig. 28.



PHOTOGRAPH OF A WHITE-ANT'S NEST TAKEN IN SOMALILAND BY MR. F GILLETT.

Fig 29

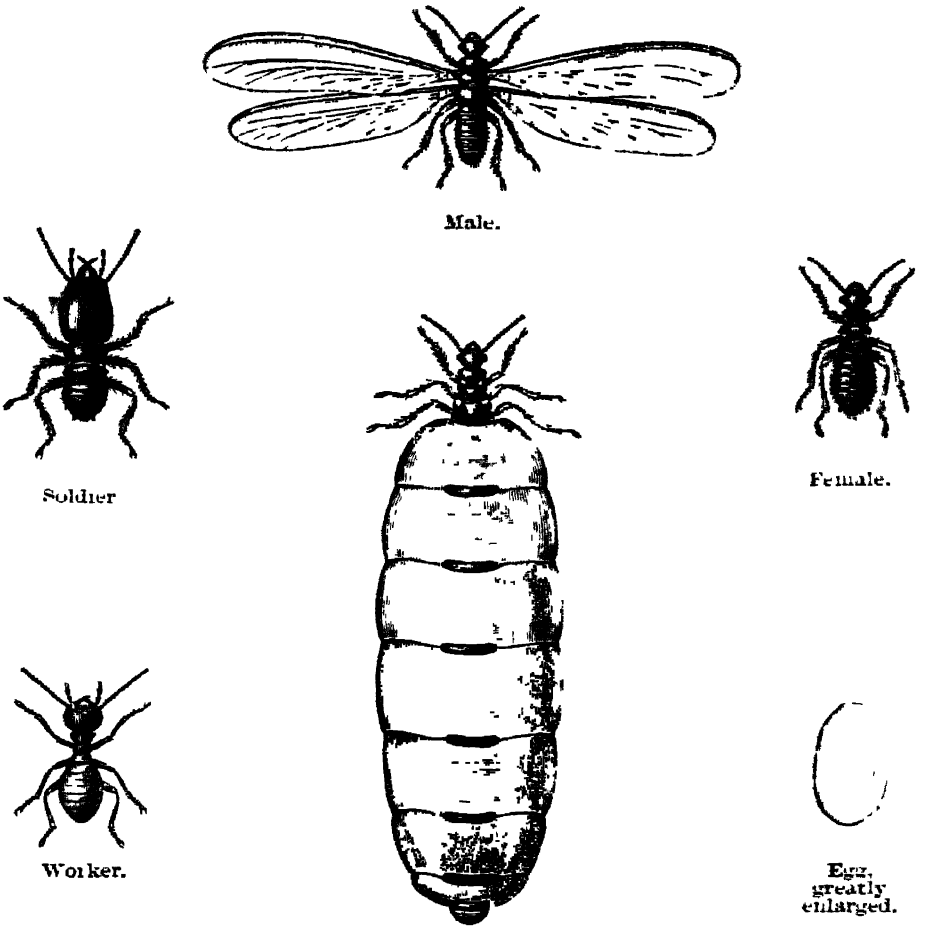


QUEEN'S CELL OF *Termes bellicosus* (203). ½ NAT. SIZE.
(Photographed from a specimen in the Museum)

[*To face p.* 28.

consists of cells, connected by galleries. Portions of these nests are exhibited in the wall-cases, as well as photographs of the whole nests. One kind of nest met with in Australia, of a flat, wedge shape, is

Fig. 27.



Female, distended with eggs.

Termes fatalis, all enlarged. (1307.)

remarkable for the fact that its broad, flat surfaces always face nearly east and west.

A large photograph showing some of these nests is suspended on the wall. A nest met with in Sierra Leone has the upper part

Wall-case 9. built in three or four storeys (177). Examples are exhibited in Wall-case 9 (fig. 30).

In the underground nests the queens live in specially constructed cells, which are often of considerable size (203, fig. 30). Occasionally two queens are found in the same cell (193).

Some good examples are exhibited both in the table-case and in the wall-case. The queen when once established in this cell never leaves it. She is supplied with food by the workers, and the eggs as soon as laid are carried away to other parts of the nest through small holes in the sides of the cell.

The duty of the soldiers is to guard the nest, and for this purpose they are provided with very large heads, which are sometimes armed with a strong spine or spike. Others have large powerful jaws.

Some excellent examples of the destruction caused by these insects are shown in the wall-cases. Attention may be specially directed to the remains of a square lintel of a door of one of the Government offices in James Town, St. Helena, in which only the very hard parts remain (175). Another very good example is a piece of a greenhouse from Singapore presented by Mr. H. N. Ridley, showing very deep excavations (159, fig. 31). Most of the destruction is carried on secretly, the ants rarely showing themselves, the outside of the object attacked being left intact so that the mischief is not observed. A small insect box brought to this Museum from Trinidad was found to have the lid completely hollow (163). Some live ants were still in it. This is exhibited in the wall-case.

The wings and remains of Termites have been found in abundance in a fossil state in Mesozoic strata in Europe.

Table-case 35. Immediately after the Termites are some examples of the very peculiar insects of the family *Embiidæ* (1318). These are closely allied to the *Termitidæ*, but have no soldiers or workers. Their metamorphoses are incomplete, the fully adult only differs from the young in size, and in some instances in having wings. Some species never have wings. They are in many respects very primitive insects, having the front and hind wings similar in size, form and neuration; the last being of a very simple character with few cross nervures. As the mesothorax is very long, the front and hind wings are remarkably far apart. The front and middle legs are wide apart at their bases and are placed at the side of the body as in the *Phasmidæ*; but the hind legs are closer together.

Fig 30

White-Ant's Nest from Sierra Leone (177)
¼ Nat. Size.
(Photographed from a specimen in the Museum.)

Fig. 31.

Wood Excavated by White Ants, Singapore (159).
½ Nat. Size.
(Photographed from specimen in the Museum.)

(*To face p.* 30.

The tarsi have three joints, the front ones are of very singular form.

The species are sometimes met with singly, but they are often social in their habits, and have been found congregated in a mass of webs, an example of which is exhibited (1311).

They occur in S. Europe, Asia, Africa and America.

Sub-Order CORRODENTIA.

These are small soft-bodied insects with incomplete metamorphoses. The head is free, generally rather large, wide, with prominent eyes. The mouth is provided with mandibles. The antennæ are long, composed of about a dozen joints. The prothorax, mesothorax and metathorax are nearly equal; the prothorax not very large. The wings are four, with a few branching veins which take curious curves; the hind pair smaller than the front pair. The front pair are held roof-like when at rest; the hind pair slightly folded at the base. The tarsi have two or three joints. Table-case 35.

Some species never have wings.

These insects are very common on trunks and branches of trees. Many kinds prefer dead wood.

One kind, *Atropos divinatoria* (1316), is very common in houses, especially if damp. It is sometimes destructive to collections of plants or insects. It is one of the insects called Death-watches. It makes a regular tapping noise, probably by striking its jaws against the wood it is resting on, the sound much resembling the ticking of a watch. It can only be heard in a room where there is absence of noise.

Sub-order PLECOPTERA.

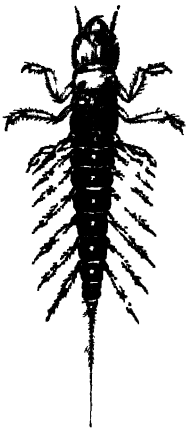
The *Perlidæ* or Stoneflies (1320–1325) are insects of moderate size, with incomplete metamorphoses. The head is slightly imbedded in the prothorax; with long, slender antennæ composed of very numerous joints. The hind wings are larger than the front ones; held horizontally over the back when at rest, with the inner portion of the hind pair folded. The tarsi have three joints. The larvæ live in water, feeding on decayed vegetable matter, but some are carnivorous. When fully grown they crawl out of the water, the skin splits down the back, and the perfect insect emerges. The adults frequent trees and are very active.

Sub-order SIALIDA.

Table-case 35.

The *Sialidæ* or Alder-flies (1327–1334) have the head imbedded in the prothorax. The antennæ are long and slender, composed of

Fig. 32.



Larva of Alder-fly (*Sialis lutaria*). Enlarged.

numerous joints. The prothorax is rather large. The front and hind wings are of different shape, held roof-like when at rest, the hind ones ample and folded when not in use. The tarsi have five joints.

Their metamorphoses are complete. The eggs of the common British Alder-fly, *Sialis lutaria*, are laid on blades of grass, etc., generally near water. The larva (fig. 32) as soon as it leaves the egg makes its way to the water, where it spends most of its time in the mud, feeding chiefly on other small aquatic larvæ. The abdomen is furnished with tracheal gills. When fully grown the larva leaves the water and buries itself in the earth, where it turns to a pupa.

Sub-order PLANIPENNIA.

Table-case 36.

The next principal division of this order comprises the *Planipennia*, Snake-flies, Ant-lions, etc. These all have the head free (except the *Rhaphidiidæ*). The thorax is generally compact with the prothorax small; but in the *Rhaphidiidæ*, *Mantispidæ* and *Nymphidæ*, the thoracic segments are more or less distinctly separated, and the prothorax is larger. The four wings are nearly or quite similar in form and size (except in the *Nemopteridæ*), held

roof-like when at rest, the hind pair never folded. The tarsi have five joints. The metamorphoses are complete.

They are divided into ten families.

The first family contains the Scorpion-flies, *Panorpidæ* (1335), so called from the curiously developed apex to the abdomen of the males. They have the head prolonged downwards so as to form a beak. The antennæ are slender, composed of numerous joints. The wings are rather narrow, with numerous cross nervures. Table-case 35.

The larvæ feed in rotten wood.

The British species are common in woods. One curious genus, *Boreus* (1346) is wingless. It is British and lives in moss, and when walking much resembles a large flea.

The *Rhaphidiidæ* (1347) are insects of rather small size, remarkable for the length of the head and prothorax, whence their popular name Snake-flies. The antennæ are slender and composed of many joints. The four wings are equal and nearly similar, with a glassy appearance, the veins form a network. The larvæ are very active, carnivorous, living chiefly under loose bark of trees and logs.

The *Mantispidæ* (1348) are at once recognised by the remarkable form of the front legs which resembles those of a *Mantis*, formed for seizing small insects. The head is free, transverse, with rather large eyes. The antennæ are not very long, composed of many joints. The four wings are alike, equal, or with the hinder pair slightly smaller, the neuration forms a delicate network.

They are very numerous in tropical countries, and one is found in S. Europe. There is no British representative.

The eggs are laid with a threadlike attachment as by the Lacewing flies. The young larva is very active. It attaches itself to the egg-sack of spiders, which it enters and later on feeds on the young spiders. It then changes its skin, completely alters its appearance, and is no longer active. It changes to the pupa within the larval skin.

The *Nemopteridæ* are easily known by the great length of the hind wings, which are very narrow, but sometimes dilated at the tips. One of the longest is *Halter imperatrix* (1353) from West Africa (fig. 33). Another remarkable form is one recently discovered in Asia Minor, *Chasmatoptera Sheppardi* (1357). Species of the genus *Croce* have the hind wings almost thread-like.

The neuration approaches that of the *Ascalaphidæ*, the fourth vein commencing about the middle of the wing.

The head is transverse with rather prominent eyes. The antennæ long or moderately long, slender.

Table-case 36.

The species at present known are chiefly South European, African and Australian. A larva believed to be that of *Nemoptera* is found in the tombs in Egypt. It is remarkable for the great length of its neck (1354).

The *Nymphidæ* (1361) have the head free, transverse, with prominent eyes. The antennæ are moderately long and slender. The four wings are equal and similar. They show a typical neuration, the eleven veins being all distinguishable, with the fourth and sixth both complete to the base, and the seventh emitting a branch from about the middle. The tarsi have the claws furnished with membranous lobes.

These insects are Australian. Nothing is known of their habits.

The *Osmylidæ* (1362–1365).—The insects usually included in this family have the head variable, sometimes slightly imbedded in the prothorax, but generally nearly free, transverse, with rather prominent eyes. The antennæ are slender, of moderate length. The neuration of the wings is somewhat similar to that in the *Nymphidæ*, but the seventh vein is parallel to the sixth (and 6A), does not emit a distinct branch to the hind margin, and appears to terminate at a cross vein at some distance from the margin. Nearly the whole wing has a border of fine forked veins.

These delicate and beautiful insects are widely distributed. *Osmylus chrysops* (1362) is not uncommon in the New Forest. The larva is found under stones or in moss in or near water.

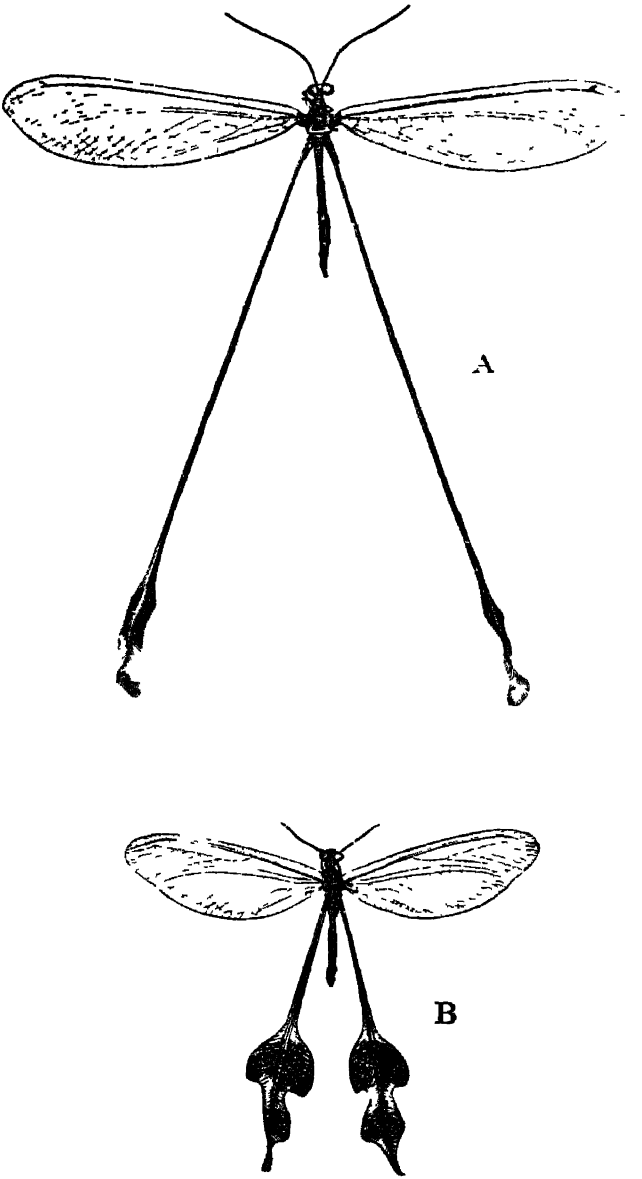
The genus *Dilar* is remarkable for the comb-like antennæ of the male. The genera *Ithone*, *Rapisma* and *Psychopsis* (1365) are included in this family, but they are very aberrant.

The *Hemerobiidæ* are rather small insects, with very short prothorax. The neuration of the wings is a still further departure from that seen in the *Nymphidæ*. The fourth vein is in part or wholly absent, and there are numerous veins branching directly from the third vein.

The larvæ are carnivorous and live chiefly on *Aphidæ* (Green-fly), from which they suck all moisture. They have the curious habit of placing the empty skins of their victims, as well as fragments of vegetable matter, on their backs so that they are often completely concealed.

The *Chrysopidæ* closely resemble the *Osmylidæ*, but have the antennæ of great length. The neuration of the wings divides the surface into a number of oblique oblong cells; the fourth vein curves away from the third; the fifth is absent.

Fig. 33.



NEMOPTERIDÆ.

A. *Halter imperatrix* from W. AFRICA. B. *Chasmatoptera Sheppardi* FROM ASIA MINOR. SLIGHTLY REDUCED.

(Photographed from specimens in the Museum.)

[*To face p.* 34.

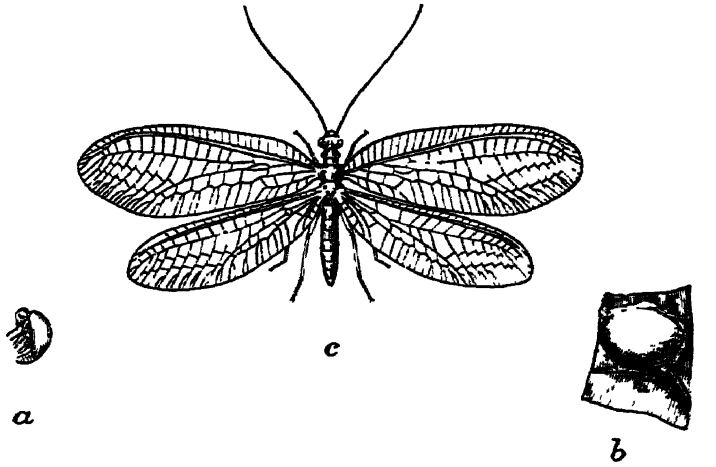
There are often some curiously-formed cells at the base of the wing. Table-case 36.

Their delicate gauzy wings have won for them the name of "Lacewings," whilst from their bright golden or coppery eyes they are often called "Golden-eyes." When handled they have a strong disagreeable smell.

The eggs, which are laid in groups, are often found attached to leaves and other objects. They are white and are attached by long delicate threads.

The larvæ feed on *Aphidæ*, which they hold up in the air in their long jaws until all moisture is sucked out. When walking they use

Fig. 34.



a, Pupa; *b*, cocoon; and *c*, imago of Lacewing (*Chrysopa perla*), twice natural size. (1370.)

the tip of the abdomen as a lever and a sucker, so that if they lose their hold of a leaf they can hang by the tip of the abdomen until they regain their footing. When full grown they spin a round silken cocoon in which they turn to the pupa.

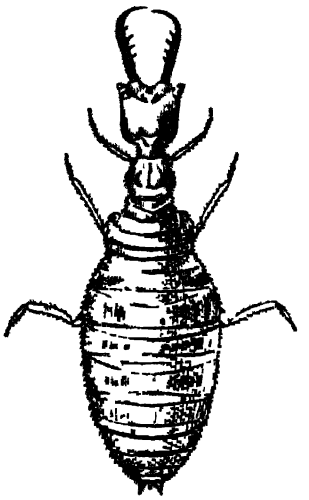
The *Coniopterygidæ* (1372) are very small insects, having the body covered with a white powdery substance. The wings have a very simple neuration, with very few cross nervures. The hind pair are smaller than the front ones.

These insects are common on fir trees. They resemble the *Chrysopidæ* in their habits and metamorphoses. Their larvæ have been found feeding on minute scale-insects.

Table-case 36.

The *Ascalaphidæ* (1373–1382) are easily recognised by their long slender antennæ, which terminate in a spoon-shaped club. The head and thorax are generally hairy. There is considerable variation in the form and colour of the wings. The front ones are frequently angulated on the hind margin at the base, the angle in some cases forming a lobe. The cells at the tip of the wing are irregular and not very numerous. The fourth vein is joined by the fifth about the middle of the wing, and joins the third at some distance from the base. The legs are spiny and not very long; the claws long and gently curved.

Fig. 36.



Larva of a *Myrmeleon*. (1388.)

The larvæ closely resemble those of the *Myrmeleonidæ*, but have a series of tubercles at the sides of the body (1374).

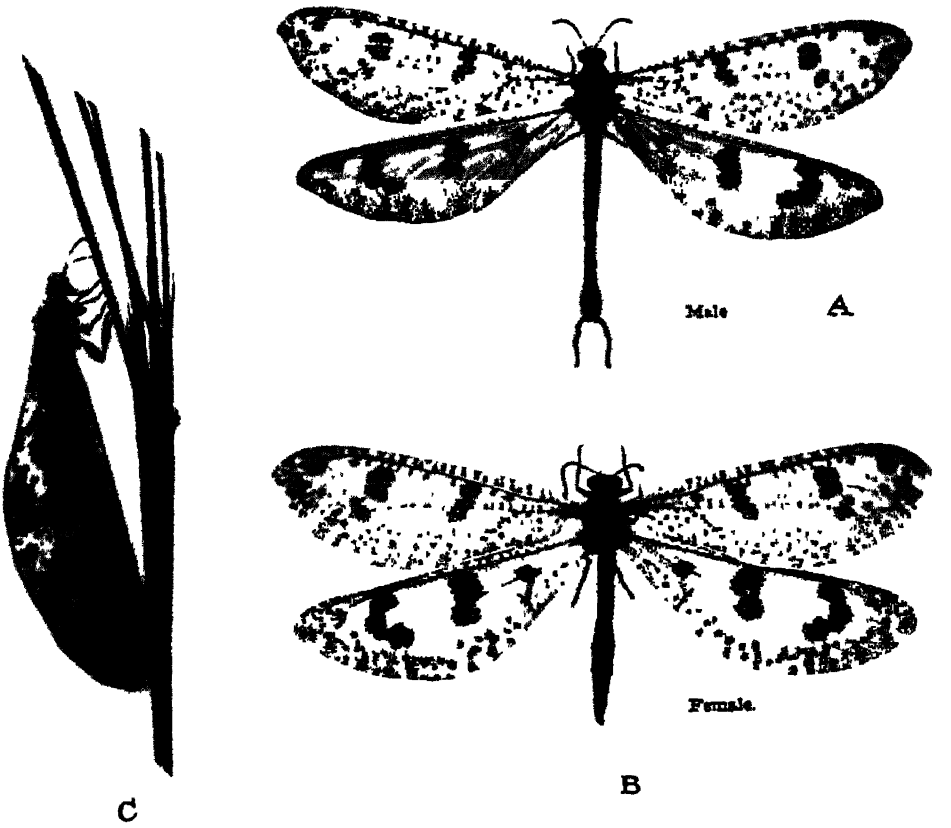
The *Myrmeleonidæ* (1383–1385) have the wings generally of a more delicate texture than the *Ascalaphidæ*. The front and hind pairs are similar in shape and neuration, gradually narrowed to the base. The apex of the wing has a large number of fine veins radiating from the second and third veins. The antennæ are short, more or less thickened towards the tip (fig. 35).

The larvæ, fig. 36 (1388) are carnivorous. They live in circular pits excavated in the sand. These they make with their large flat heads, which they use as a shovel, jerking the sand to a considerable distance. When the pit is deep enough the larva rests concealed at the bottom with the jaws exposed ready to seize any ant or other insect that may fall into the pit. Their popular name of "Ant-lions" is due to this habit. They are found in Southern Europe and all tropical countries.

Sub-Order AGNATHA.

The sub-Order *Agnatha* (1400–1409), consists of a single family (*Ephemeridæ*), popularly known as May-flies. They are very delicate insects with imperfectly-developed or no mouth parts. The antennæ are extremely short, and terminate in a bristle. The hind wings are much smaller than the front pair. The abdomen is furnished

Fig. 35.



ANT-LIONS.

A. B. *Pulpares libelluloides*, FROM S. EUROPE.

C. *Palpares cephalotes*, FROM ANGOLA (1383). ½ NAT. SIZE.

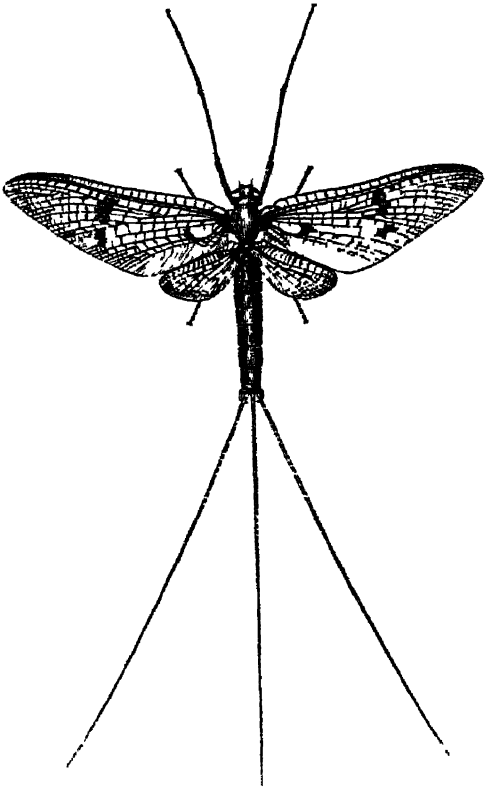
(Photographed from specimens in the Museum)

[*To face p.* 36.

with two or three long, thread-like tails (fig. 37). When at rest the wings are held together erect, the abdomen slightly curves and the tails are directed upwards.

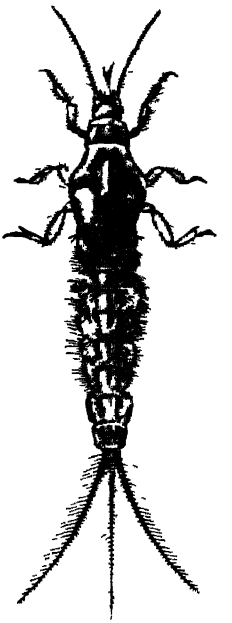
The early stages of these insects are passed in the water. The larvæ vary greatly in form according to their habits, and they are a considerable time arriving at maturity. In some cases this takes

Fig. 37.



May-fly (*Ephemera vulgata*), enlarged. (1400.)

Fig. 38.



Nymph of *Ephemera vulgata*. (1401.)

more than one year. The mouth parts are well developed, the mandibles in some cases being very large (1408). The abdomen is furnished with complex tracheal gills. There are sometimes leaf-like plates at the sides of the body (vibrated at frequent intervals in the water), sometimes they are tassel-like or feathery and are curved over the back. When the nymph (fig. 38) is full

Table-case 36.

grown it makes its way to the surface of the water, the skin splits and the winged insect emerges. This process occupies a very short time, sometimes only a few seconds. This winged form, called the *sub-imago*, is, however, still enveloped in a delicate skin; this it throws off either immediately or soon, and the insect is then in its perfect state.

The food of the larvæ is chiefly vegetable matter, but some species are at least in part carnivorous.

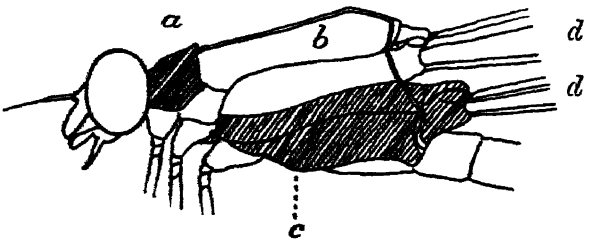
Some species of May-fly occur in swarms and appear in the air like a fall of snow. Specimens swept from a railway platform in Egypt after one of these swarms had occurred are exhibited (1409). A few of another swarm from Germany are in the same case in spirit (1403).

Sub-Order Odonata.

These insects, popularly called Dragonflies (1410–1453), are insects with incomplete metamorphosis. The head is very large, concave behind, with very slender attachment to the thorax, so that it has complete freedom of action. The eyes are very large, sometimes touching each other above. The antennæ are very short and terminate in a bristle. The wings are equal or very nearly so. Although transparent they are somewhat hard and brittle. The veins form a network. The abdomen is very long.

One great peculiarity of this Sub-Order is the form of the thorax.

Fig. 39.



Side view of the thorax of *Mecistogaster*.

a, prothorax; *b*, mesothorax; *c*, metathorax; *d*, *d*, bases of wings.

When viewed sideways the segments are seen to slant, so that the legs are in front of the wings (fig. 39). In other insects the base of the legs is under the base of the wings. The prothorax is very

small. The mesothorax and metathorax about equal. The upper surface is not fixed as in other insects but the parts are movable, which gives the wings great freedom.

In their early stages they live in water, and (like the adult) are carnivorous, feeding on other insects, snails, etc.

The larva possesses an extraordinarily developed labium. When at rest this is folded beneath the head, the front part of it forming a mask; but it is jointed and can be darted forward with great rapidity when the insect seizes its prey with the terminal toothed appendages (1410).

The Odonata have been arranged in two divisions :—

Div. I.—ANISOPTERA, in which the front and hind wings are more or less unlike, the hind pair enlarged near the base. This division contains the families *Libellulidæ*, *Cordulüidæ*, *Gomphidæ*, *Cordulegastridæ* and *Æschnidæ*. The characters of these families are chiefly in the form of the head and the neuration of the wings as explained in the labels exhibited.

They fly with great rapidity.

Div. II.—ZYGOPTERA in which the wings are alike, both pairs equally narrowed at the base. This division consists of two families, the *Calopterygidæ* (1439–1446) and *Agrionidæ* (1447–1453). Table-case 37.

Among these are some of the most brilliantly coloured insects known. Unlike the *Anisoptera* they are comparatively slow fliers, and are generally seen fluttering about the herbage at the sides of ponds.

Dragonflies have been found plentifully in a fossil state in Tertiary strata, including species of *Libellula* and *Agrion*, both larvæ and perfect insects, differing but little from those of the present day. Some large species have also been found as far back as the Lower Lias.

The remains of an enormous insect, *Meganeura monyi*, measuring two feet in expanse of wings have been found in the Carboniferous strata. It has four equal wings, and is evidently not far removed from the Dragonflies. The neuration of the wings differs, however, in some important characters, and the shape of the body, so far as can be seen, is different. Its place appears to be between the Mayflies and Dragonflies. A drawing of one of the wings, natural size, is exhibited. There are no specimens in the Museum collection.

Order TRICHOPTERA.

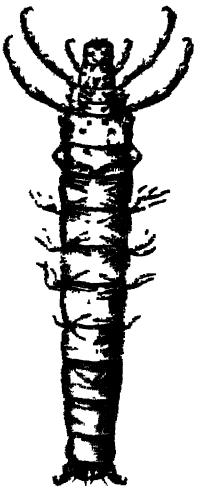
Table-case 37.

The second half of Table-case 37 contains the TRICHOPTERA or Caddis-flies.

These insects are sometimes regarded as a sub-order of the *Neuroptera*. They have the head free. The antennæ are nearly always long and thread-like, tapering to the apex. The mouth parts are small; the mandibles absent or very rudimentary; the maxillary palpi very variable, in some genera very large. The thorax is compact; the prothorax very small. The legs are long and slender with five-jointed tarsi. The front wings are more or less clothed with hair, slightly more leathery than the hind pair, held roof-like when at rest, the hind pair ample and pleated when at rest.

The larvæ live in ponds and streams; their food consists of vegetable matter. For the most part they live in cases which are built in various ways and of different materials, such as stones, sand, shells, bits of weed, &c. Some of these cases are coiled, and being built of fine sand have been mistaken for Mollusc shells (1478).

Fig. 40.



Larva of Caddis-fly. Twice natural size.

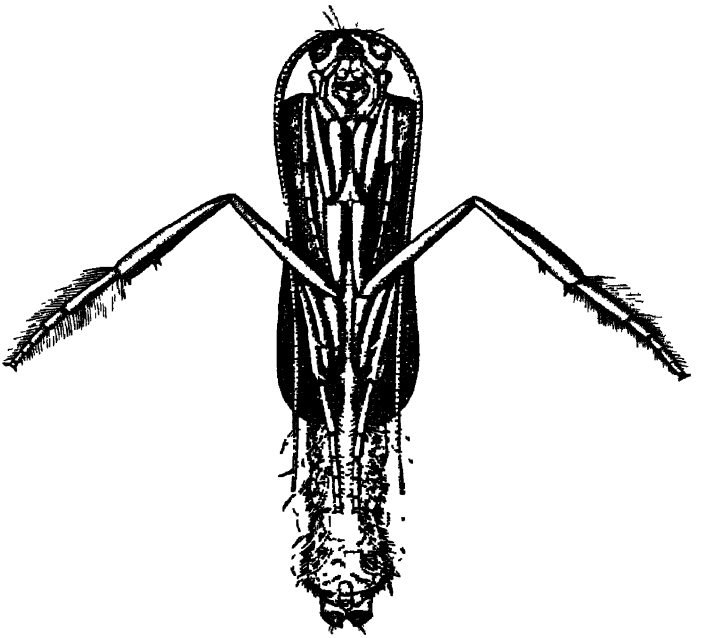
The ordinary Caddis-fly larva (fig. 40) has the body soft, except the head and thorax that are exposed (1461). The first segment of the abdomen projects on each side, and has on the back a small tubercle which terminates in a sharp hook directed backwards. These projections secure the body in position in the case, whilst at the same time the water can pass freely through the tube; they also enable the larva to stretch itself out of the tube in search of food. Some of the segments are furnished with floating filaments that serve as gills. At the end of the body there are two strong hooks, which give the larva a firm grip on its case, and enable it to draw back rapidly into the case at the approach of danger. They turn to the pupa within the case, but when ready to turn to the perfect insect, they leave the case, swim to the surface of the water (using the middle legs, which are developed like oars for the purpose), the skin splits down the back and the fly emerges.

The perfect insects may be found on trees and herbage near water. Some of the very small species so closely resemble

small moths that they require careful examination to distinguish them.

The principal families are *Phryganidæ*, *Limnophilidæ*, *Sericosto-*

Fig. 41.



Pupa of Caddis-fly in swimming position.
Twice natural size.

matidæ, *Leptoceridæ*, *Œstropsidæ*, *Hydropsychidæ*, *Rhyacophilidæ* and *Hydropsilidæ*.

Order MALLOPHAGA.

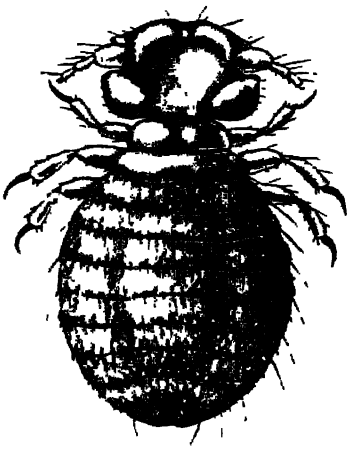
The *Mallophaga* (1501–1508), commonly called Bird-lice, are small, wingless insects, with flat bodies, which undergo very little change in their growth to maturity. The head is large and free. The mouth is furnished with strong mandibles, lodged in a cavity beneath the head. The prothorax is distinct but not large. The mesothorax and metathorax are often only distinguishable from the abdomen by the legs being attached to them. The legs are attached to the sides of the segments. The tarsi have two (rarely three) joints, terminating in one or two claws.

The majority of the species live among the feathers of birds.

Table-case 37. Drawings and specimens of *Trichodectes latus* (1501, fig. 42) found on dogs, *Menopon pallidum* found on fowls, and other species are exhibited.

Like most parasites they are difficult to locate satisfactorily in

Fig. 42.



Trichodectes latus, from dog; enlarged thirty-six times.

any natural system, but they appear to be most nearly allied to the *Orthoptera*.

Order LEPIDOPTERA.

Table-case 38. On the west side of the gallery are cabinets of British Lepidoptera. Four contain the collection of caterpillars prepared and presented by the Rt. Hon. Lord Walsingham. Another contains the collection formed by the late William Buckler, the author of "The Larvæ of the British Butterflies and Moths," published by the Ray Society. It was presented to the Museum by Robert Newbury, Esq.

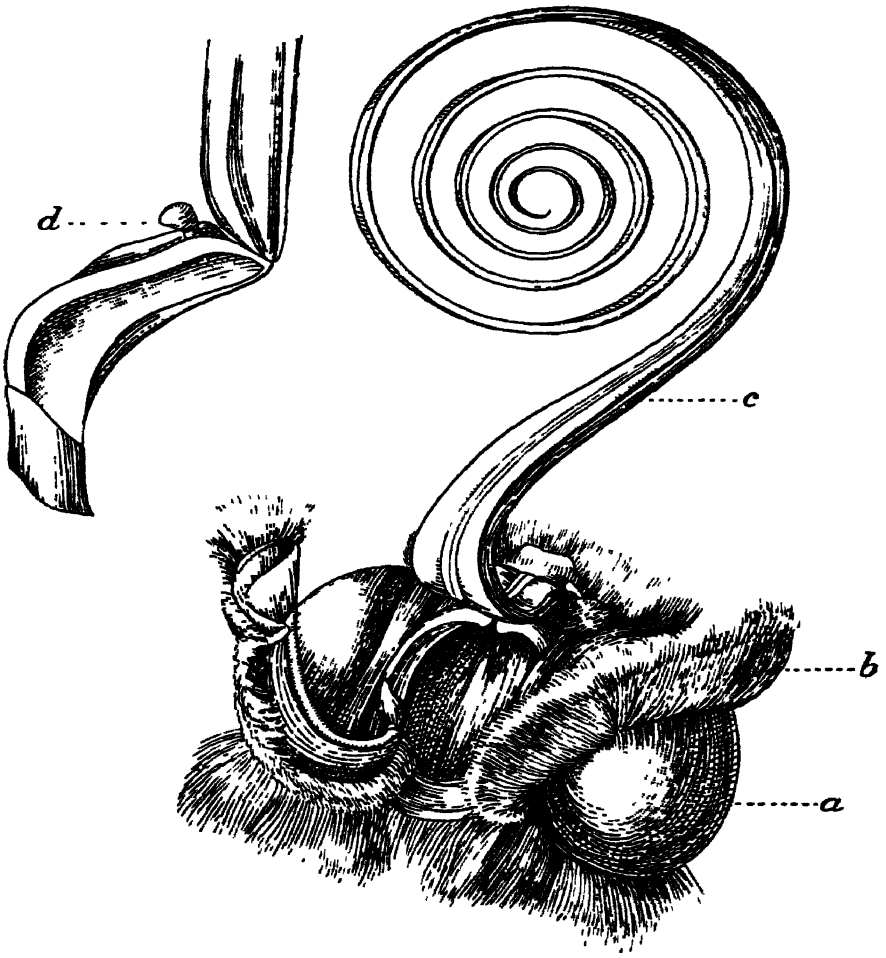
The foreign Lepidoptera are in cabinets on the East side of the gallery.

The insects of this Order are popularly known as Butterflies and Moths.

They undergo a complete metamorphosis. The larva is popularly called a caterpillar; the pupa a chrysalis. The perfect insect has the head free. The thorax is compact; the prothorax very small; the mesothorax very large. The wings are very variable, clothed (as well as the body) with scales. The mouth parts (Fig. 43) are

imperfectly developed, except the maxillæ which (except in a few cases) are greatly prolonged and united by their edges to form a proboscis or tube (through which moisture can be drawn into the

Fig. 43.



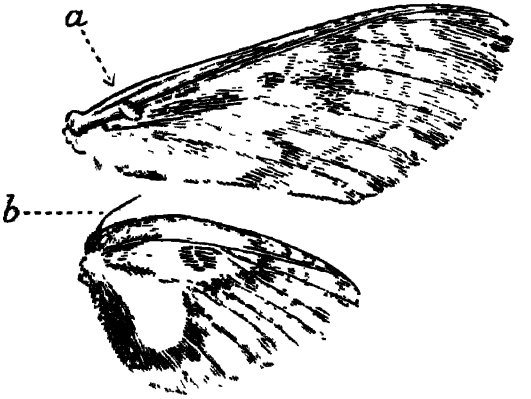
Head of a Sphinx moth showing the parts of the mouth and proboscis.
a, Eye; *b*, labial palpus; *c*, maxillæ; *d*, maxillary palpus on base of maxilla.

mouth), coiled like a watch-spring when at rest. The labial palpi are well developed, usually standing up in front of the head, sometimes of great length. The maxillary palpi are generally very small or absent, except in the most primitive family *Micropterygidæ*, where they are well developed.

The *Lepidoptera* are usually divided into two great groups, LEPIDOPTERA HETEROCERA and LEPIDOPTERA RHOPALOCERA.

The *Heterocera* or Moths generally have the hind wing united to the front wing by a "frenulum," which hooks into a strap on the

Fig. 44.



Wings of Deaths-head moth, underside.

a, Strap which holds the frenulum; *b*, frenulum.

under side near the base of the front wing (fig. 44). They have very various antennæ, generally long, slender and tapering to a point, often fringed and frequently comb-like. Comparatively few have them thickened towards the tip.

The *Rhopalocera* or Butterflies have the antennæ terminating in a club. This is very variable in shape and extent and is sometimes very slight. The hind wings are not united to the front ones by a frenulum.

The *Heterocera* are divided into numerous families. The drawings and explanatory labels are in course of preparation, and will be placed in Table-cases 38–41.

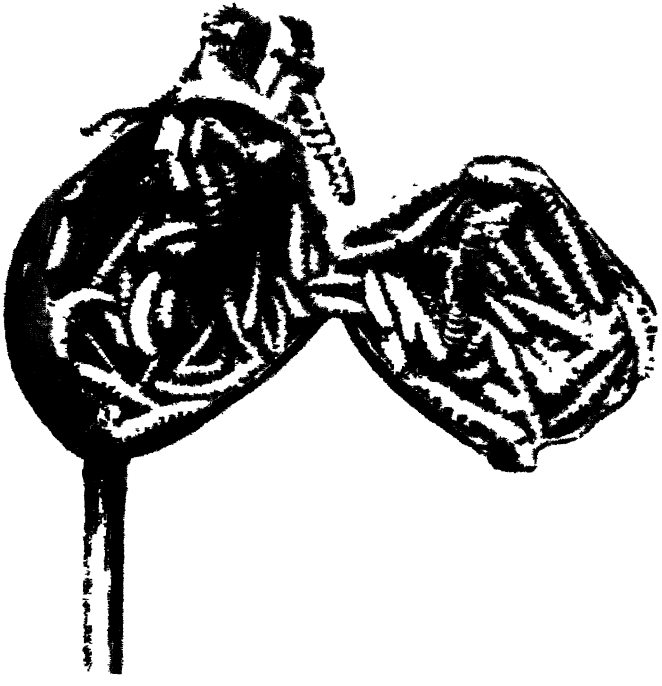
In Table-case 40 will be seen a series of specimens illustrating the life-history of the common Mulberry Silk-moth, *Bombyx mori*. This species has been cultivated for so many centuries that its origin is uncertain, but it is probably a native of China.

On a shelf on the east side of the gallery are models and drawings illustrating the habits of various species, many of them of interest on account of the injury they do to fruit trees, &c.

Wall-case 8. In Wall-case 8 on the west side of the gallery are some interesting

Fig. 45.

Fig. 46.



COMPOUND COCOONS OF A MOTH (*Anaphe panda*) FROM S. AFRICA (263, 265). ½ NAT. SIZE.
(Photographed from specimens in the Museum.)

(*To face p. 44.*

compound cocoons of gregarious moths. Attention is particularly called to one of *Anaphe panda* from S. Africa (263) in which there is a crowd of caterpillars, and by its side a similar nest (265) in which the caterpillars have spun their cocoons (figs. 45, 46). When the moths come out they escape by the opening at the top. (Further particulars about this nest will be found in Table-case 40.)

In the same case is a somewhat similar nest from Madagascar formed by *Hipsoides bipars*. In this instance each moth escapes by an opening made by itself (269).

The *Rhopalocera* are divided into five principal families, the characters by which these may be recognised are explained by a series of labels, drawings and specimens set out in a tabular form in Table-case 42. Table-case 42.

Order HYMENOPTERA.

Wall-cases 11–16, Table-cases 44–48.

The Saw-flies, Ichneumons, Ants, Wasps and Bees belong to this Order.

A small series of specimens will be found in drawers 1–8 of a cabinet on the west side of the gallery.

They have complete metamorphosis. The perfect insect has the head free, with slender attachment to the prothorax. The thorax is compact, the prothorax small, the mesothorax large. They have four wings with few veins; the hind pair united to the front pair by a series of hooks (except in some minute species). The basal segment of the abdomen is in varying degrees more closely united to the thorax than to the following segments, and in the majority the communication between the first and second segments is by a narrow neck or waist as in the hornet. The tarsi have five joints, except in some minute parasitic species.

They are classed in two great divisions :—

I. HYMENOPTERA TEREBRANTIA, in which the legs have a double trochanter.

II. HYMENOPTERA ACULEATA in which the legs have a single trochanter.

These are further divided into fourteen principal families. The characters by which these may be recognised are explained by specimens, drawings and labels arranged in a tabular form in Table-case 44. Table-case 44.

In the second half of the same case are some examples of Saw-flies. The metamorphosis of the common Currant Saw-fly is illustrated by a series of coloured drawings. Specimens of the fly with leaves injured by the larvæ are also shown. The eggs are laid in rows on the ribs on the under side of the leaves. Examples of another species, *Nematus propinquus*, the larvæ of which sometimes strip the leaves from Black Poplar, are also exhibited.

In the same case will be seen a female example of the Pine Borer, *Sirex gigas*, in the act of depositing eggs in wood. The larva burrows into the solid wood, and often does much damage in fir plantations.

Table-case 45.

In the next case are some examples of *Ichneumonidæ*. One of these, *Rhyssa persuasoria*, is a parasite on the larva of *Sirex*. In order to deposit its eggs on or near the larva of the *Sirex*, it is provided with a very long ovipositor, but how the insect passes this delicate instrument through solid wood is unknown. A small piece of wood with the ovipositor of a specimen in it is exhibited. Unfortunately the insect was broken when found. An allied species, *Rhyssa atrata*, with much longer ovipositor, is also shown.

Some examples of the white cocoons made by *Braconidæ* (often mistaken for spiders' nests) are shown in the same Table-case; and also a series of galls made by Gall-flies, *Cynipidæ*. An interesting series of the galls will also be found among the models on a shelf on the west side of the gallery.

Wall-cases 11 to 16 are devoted to nests of ants, wasps, and bees.

Among the ant-nests should be noticed one made by binding together leaves with silk threads (317, 319). This is the work of a moderately large pale green ant, *Œcophylla smaragdina*, a common species in India, with varieties in Africa and Australia (fig. 47).

Several brown nests from trees are exhibited. These are built by species of *Crematogaster*, and from their form have been called "Negro Heads" (301–311).

A small nest of the Provident Ant (321), *Atta barbara*, now known as *Aphenogaster barbara*, which stores its nest with seeds, is shown in the same case. Another curious nest is that of *Polyrhachis bispinosus* (327) from Brazil. This is made of soft substance and has the appearance of a sponge.

Formica fuliginosa, a common English black ant, forms its nest in hollow trees. A portion of one of their nests is exhibited (333). Another complete nest (335), found near Guildford, was built in a house under the drawing-room floor.

Fig. 47.

NEST OF AN ANT (*Œcophylla smaragdina*) FROM CALCUTTA, MADE BY BINDING LEAVES TOGETHER WITH SILK THREADS (327). ½ NAT. SIZE.

(Photographed from a specimen in the Museum.)

[*To face p* 46.

A remarkable entrance to an ant's nest is shown at the bottom of the case (339, 340). This ant, *Phidole Sykesi*, forms its nest on the side of steep hills, and round the entrance there is a curious structure, consisting of concentric walls or ridges. The object of these walls appears to be to protect the entrance from the water that rushes down the hill during heavy rain.

Specimens of various ants will be found in drawer 5 of a cabinet on the west side of the gallery, and in Table-case 45. Among them examples of the Foraging ants of Central and South America, *Eciton omnivorum*, male and worker, and soldier and worker of *Eciton hamatum*. These ants travel in enormous numbers, sometimes in narrow lines, sometimes in broad columns. They kill and carry away with them cockroaches, beetles, and all kinds of insects, and even lizards. Table-case 45.

The Driver ants of Africa, *Anomma*, are even more formidable, and when foraging will attack and destroy all kinds of insects, as well as large snakes, chickens, &c. Those that travel in this way are the workers. The males are large winged insects and are known as *Dorylus*. It is only in recent years that these insects were discovered to be the males of *Anomma;* hence the use of two names. The females are large wingless insects, and are rarely found. There is a single example in the Museum which is believed to be the female of *Dorylus nigricans*, of which *Anomma Burmeisteri* is believed to be the worker. The variation in the sizes of the individuals, and in the relative sizes of their heads, is very remarkable.

Specimens of *Œcophylla smaragdina*, female and worker, above referred to, and also workers of the "Leaf-carrying," or "Umbrella Ant," *Œcodoma cephalotes*, are in the same case.

Some eggs of an ant, *Myrmica*, are also exhibited. The "ant-eggs" sold as food for birds are not eggs, but the cocoons made by the larvæ of ants.

Wasps of the genus *Scolia* are parasitic upon the larvæ of beetles. A series of *Scolia flavifrons* is exhibited in Table-case 46. This species lives on the larva of a Rhinoceros beetle, *Oryctes nasicornis*. The female *Scolia* deposits an egg on the under side of the larva of the *Oryctes* after paralysing it with her sting. The larva of the *Scolia* does not eat the *Oryctes* larva, but gradually sucks it dry. Table-case 46.

The species of *Pepsis* and *Salius* are among the largest known wasps. A large *Pepsis* from Ecuador is exhibited.

The species of *Salius* store their nests with spiders. The large

species attack and kill even the large Mygales. The *Salius* will hover round the nest of the Mygale and sometimes entice it out by touching the spider's web, it will then pounce on the spider and render it helpless by stinging it. Sometimes a struggle takes place, and the two will roll over and over, but the wasp is nearly always victorious. A specimen of *Salius deljax* from German East Africa, with the Mygale which it had caught and was carrying away, are exhibited.

Wall-case 12, and Table-case 46.

In this case are exhibited a series of nests made by various wasps. Among these are numerous cells or nests built of mud by species of *Pelopæus*.

Pelopæus figulus (401) and *P. histrio* (403) form groups or masses of cells. Examples are exhibited in Wall-case 12 and in Table-case 51. These cells when completed are filled with insects, or more generally with spiders, to serve as food for the larvæ of the wasps. The remains of the spiders can be seen in the nest of *Pelopæus bilineatus* from N.W. India, exhibited in Table-case 46, and in the nest of *Pelopæus chalybeus* from Natal in the same case. The cells of this species are placed in pieces of bamboo. *Pelopæus lætus* from Australia (397), Wall-case 12, and *P. madraspatanus* from N.W. India, Table-case 46, sometimes build separate cells, but a curious group of cells formed by the latter species in a deserted bird's nest should be noticed in Wall-case 12 (391).

The species of *Crabro* form burrows in various places; some in the ground, others in decayed wood, in bramble stems, &c. The cells are stored with insects, most commonly perhaps with Diptera. An example of a piece of willow with cells of *Crabro cephalotes* from Barnes Common is shown in Table-case 46.

The species of *Odynerus* avail themselves of any suitable hole in which to make their mud nests. Two curious examples are exhibited in Wall-case 12, one built in the centre of a reel of cotton, the other in a blind-tassel (415).

Among other clay nests that specially deserve notice are some built by species of *Eumenes* in the shape of vases (449, fig. 48). Another standing with these, from Aden, and evidently formed by a member of this genus, is noteworthy for the size of the stones fixed on the outside (447). It is remarkable that such a small insect could carry and manipulate stones of this weight. The size of the insect can be judged by the hole through which it emerged from the nest (fig. 49).

Fig. 48.

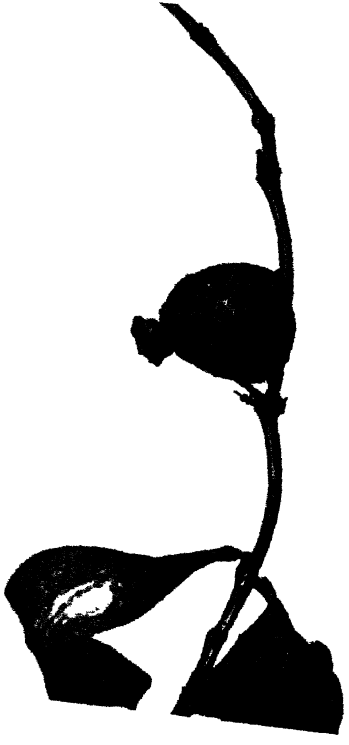


Fig. 49

NESTS OF SUCCIS OF *Lonicera* (447, 449) NAT. SIZE
(Photographed from specimens in the Museum)

(To face p. 48

Close by these are two nests built by a species of *Ischnogaster*. They were found attached to roots on an overhanging bank in Borneo by the late Mr. J. Whitehead (445). The form of the entrance with its open-work at the back should be noticed (fig. 50). Other somewhat similar nests from Ceylon, formed by another species, will be found in Table-case 46 (fig. 51). Table-case 46

Some Social Wasps build their nests without covering, others are enclosed. Among those built without cover are those of *Polistes* and *Icaria*.

In the wall-case are examples of the flat nests built in trees by species of *Polistes* (341–355). It will be observed that these are suspended by a stalk from the centre of the nest (fig. 52). The species of *Icaria* build somewhat similar nests, but instead of making them circular they increase the size of the nest by adding cells at one end, the result being a long narrow nest. One from Singapore (359, fig. 53) about a foot long is in the wall-case, and some smaller ones will be found in Table-case 46.

This case contains nests formed by various species of *Vespa* (the common wasps and hornets). The nests built by some of the Indian species attain great size; one measuring thirty-two inches in length is suspended in the middle of the wall-case. Wall-case 13 Table-case 46

The English Hornet, *Vespa crabro*, builds its nest chiefly of rotten wood, sometimes in hollow trees (499, 535), frequently in roofs of outhouses (489, 493). Those in hollows are generally without covering, but suspended nests have a thick outer case.

The other species of the genus *Vespa* are called Wasps, of which there are six British species.

The nest of *Vespa vulgaris* is somewhat similar to that of the Hornet, but is composed of much finer material. The patches on the cover are smaller, with concentric curves or wavy lines of different shades of buff and brown (of a lighter colour than in the Hornet's nest), giving the nest a very pretty appearance. This wasp prefers to build underground, but the nests are found not infrequently in roofs of outhouses (511, 515). A nest of this species was recently found in a hat which was hanging in an outhouse at Tring, and was presented to the Museum by the Hon. Walter Rothschild (507).

The nest of *Vespa germanica*, another common species, is generally underground. It is formed of vegetable fibre and is of a grey colour (465).

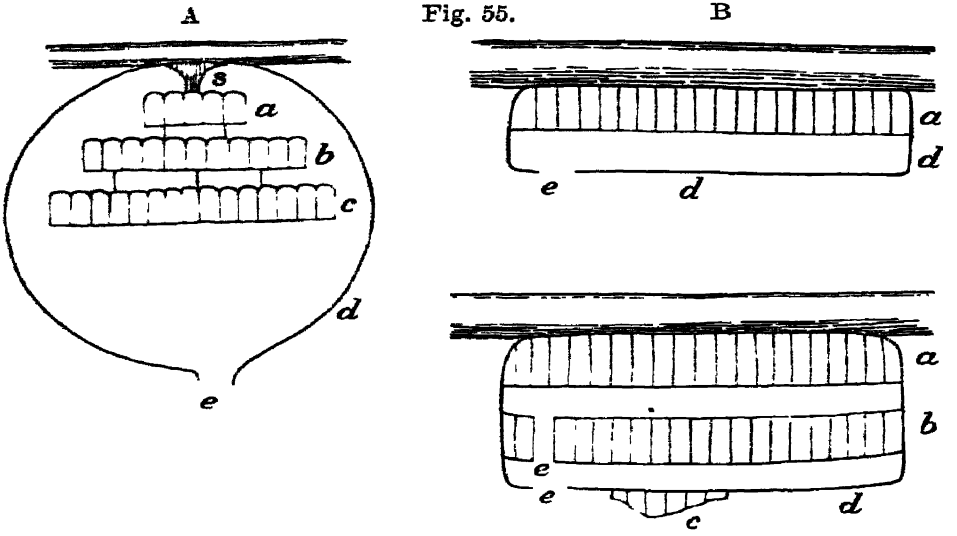
Vespa norwegica is a tree wasp. The nest is of a grey colour, with whitish marks and lines, built of vegetable fibre. The outer

cover is very delicate, almost like tissue paper (473, 475, 497). In their early stages these nests are pretty objects. Several are exhibited in Table-case 46, and one in a more advanced state will be found among the groups on the east side of the gallery (69).

Two examples of a very remarkable nest are to be seen in this case (501, 502). They are built entirely of clay, including the comb. They have been found in South America, hanging from branches, but no specimens of the insect have yet reached the Museum (fig. 54).

In the covered nests built by Social Wasps, two styles of building

Fig. 55.



Diagrams of wasps' nests. C

are noticeable. The common British wasps, *Vespa*, commence the nest with a stalk attached to some object (fig. 55, A, *s*, *a*), with a few cells suspended by it. Below this they suspend a second series of cells, *b*, hanging by stalks from the first series, then a third series, etc. The whole is surrounded by a cover or envelope, *d*, which has an opening below, *e*; this covering is enlarged as the combs are increased in number and size.

In the second style of nest (fig. 55 B) the cells are attached to some leaf or branch, without a stalk, and when a row of cells (*a*) is completed it is enclosed in a thin cover (*d*) with an opening below, generally at one side. The second row of cells is built on the outside of

Fig. 50.

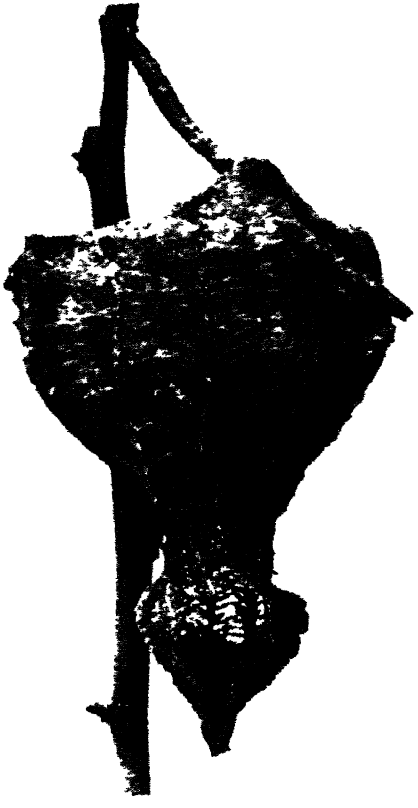


Fig. 51.

NESTS OF SPECIES OF *Ischnopsis*. NAT. SIZE.

(Photographed from specimens in the Museum.)

To face p. 98.

this (fig. 55 c), and when completed is covered in the same way, a passage (*e*) *through* the comb being left for access to the first row. A third row of cells (*c*) is then built in the same way. The Brazilian wasps of the genera *Polybia*, *Chartergus*, etc., build in this way, and numerous nests are exhibited. The covering of the nest of *Chartergus chartarius* is nearly white and smooth, and in this and in its texture exactly resembles card, whence it has been called "the Card-making Wasp." One very large example exhibited (573, fig. 56), from the river Amazon, presented by Mr. G. Brocklehurst, contains twenty-two rows or storeys. Wall-case 15. Table-case 46.

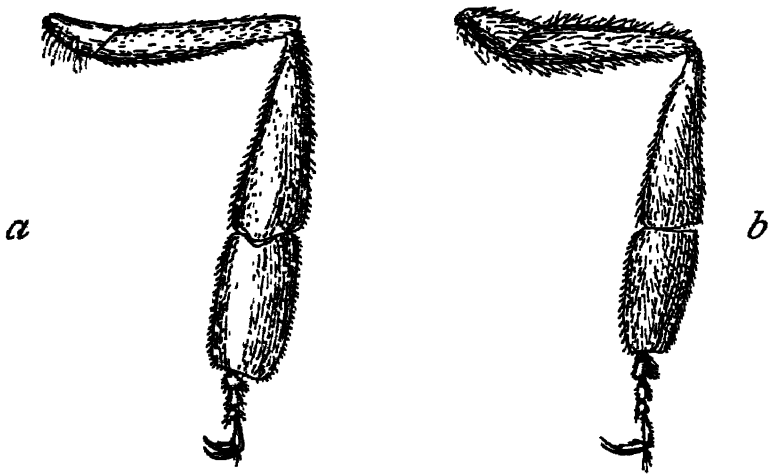
In Wall-case 16 are various nests of bees. Species of the genus *Osmia* will make a nest in any place which appears to them suitable, garden locks being sometimes chosen. A pipe with cells of *Osmia rufa* is exhibited (647), and another still more curious example is a book with a series of cells (631). This book was in a book-case pressed against the back; this left just room for the bee to get behind it. It is from Hawkhurst, Kent, and was presented by Miss Evelyn Hardcastle. Another nest built between two flowerpot saucers is exhibited in Table-case 48. Wall-case 16.

Three disused birds'-nests which have been used by humble-bees to build nests in are exhibited (639, 643). One of these nests from East Clandon, Surrey (641), has been attacked by a moth (*Aphomia*), the caterpillars of which having fed on the wax of which the bees' cells are made, have spun their cocoons on the top.

At the top of this case will be seen a single comb of great size formed by an Indian honey-bee, *Apis dorsata* (609). This honey-bee, unlike the common honey-bee, *Apis mellifica*, does not build in hollow trees, etc., but suspends the combs from the branches of trees without covering. An excellent photograph of a group of combs of this species is shown in Table-case 47, which is devoted to the explanation of the habits of honey-bees. Greatly enlarged drawings are exhibited to show the difference in the structure of the queen, drone and worker. The worker has the femora clothed with long barbed hairs (fig. 58 *a*); the tibia is concave on the outer side, the edges furnished with long-curved hairs, the whole thus making a sort of basket in which pollen is collected (*b*). The apex of the tibia is furnished with a series of teeth like a comb, with which the wax is removed from the abdomen (*c*). The underside of the first joint of the tarsus has rows of short stiff hairs, the whole forming a brush with which to collect the pollen and put it into the basket on the tibia (*d*). Other points of interest in connection with this bee are Table-case 47.

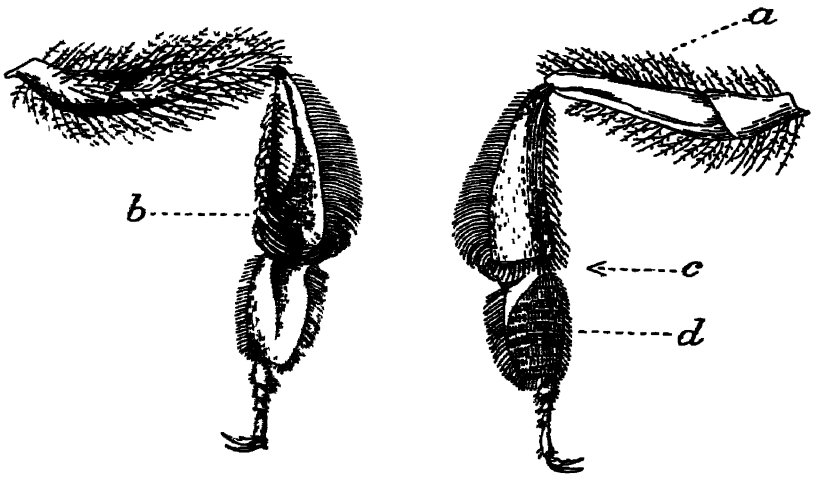
explained by drawings and specimens. The visitor should not fail to notice the flakes of wax removed from the abdomen of a specimen. It will be seen that these are nearly transparent, and it is only after

Fig. 57.



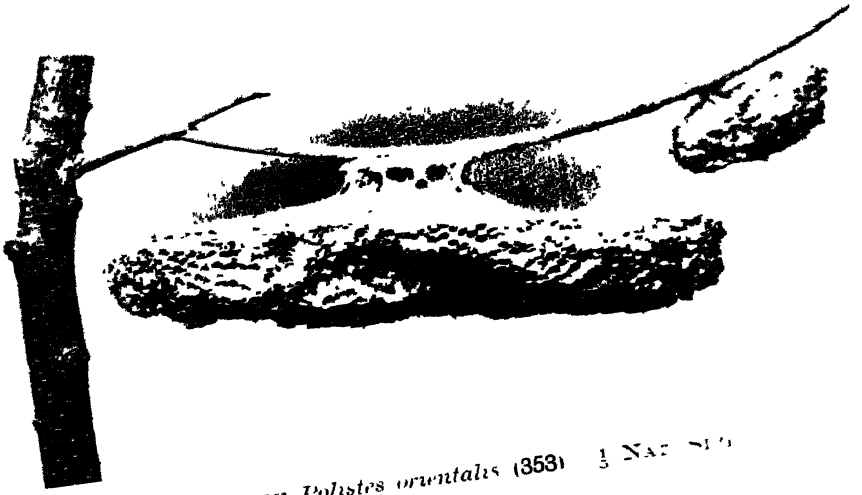
a, Hind leg of drone ; *b*, hind leg of queen honey bee.
(Enlarged 6 times.)

Fig. 58.



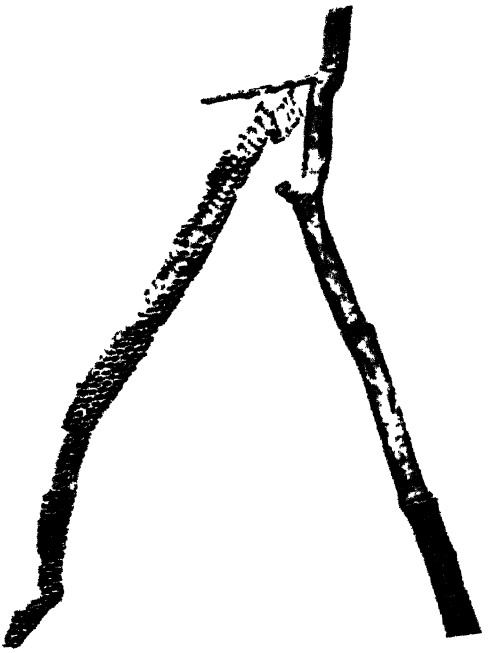
Upper and under sides of the hind leg of worker honey bee.
(Enlarged 6 times.)

Fig 52.



NEST OF *Polistes orientalis* (353) ⅓ NAT. SIZE.

Fig. 53.



NEST OF A SPECIES OF *Icaria* (359). ¼ NAT. SIZE.

(Photographed from specimens in the Museum.)

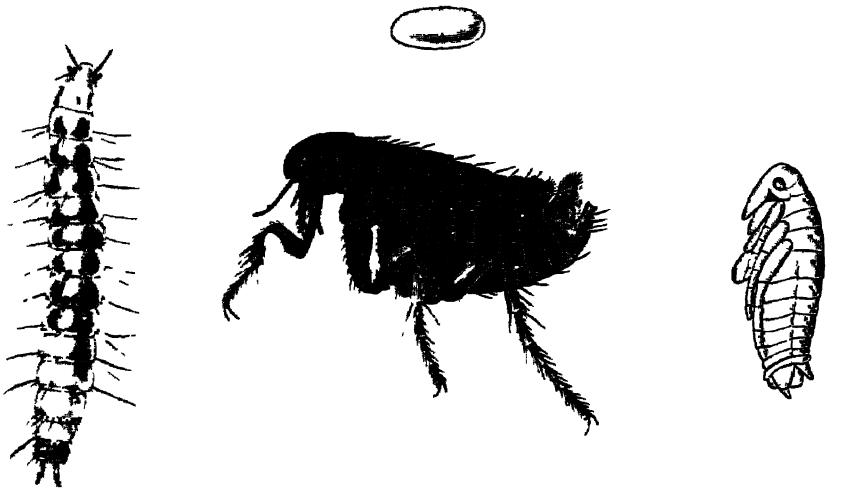
[*To face p.* 52.

character. They are extremely active. Drawings of some of the most interesting species are exhibited in Table-case 49. The pupæ are very variable.

Table-case 49. In Table-case 49 will be found a few examples of Fleas (*Pulicidæ*), with drawings of the egg, larva and pupa of the Common Flea (*Pulex irritans*) (fig. 59).

A considerable number of different kinds of fleas are known. Most of them live on Mammals and Birds, or are associated with them. The larvæ often breed in birds' nests, &c. The largest known flea, *Hystrichopsylla talpæ*, is found in the nests of moles and field mice.

Fig. 59.

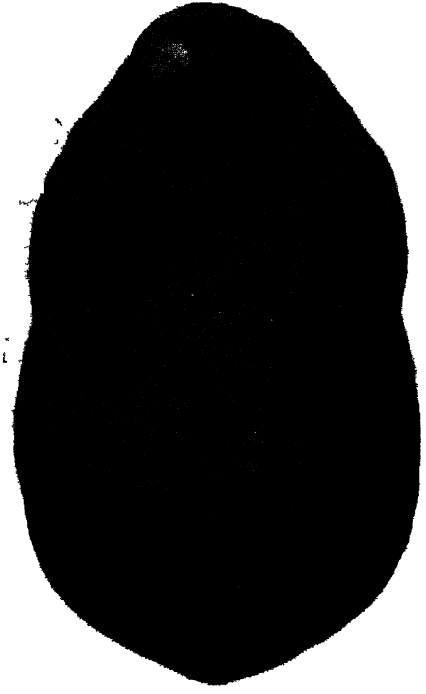


Egg, larva, pupa and imago of the common flea (*Pulex irritans*).
(Enlarged 20 times.)

The Common Flea breeds in neglected dirty houses, and the larvæ, which are very active little creatures, have been found in fluffy matter that had been allowed to collect between floor boards; also in old wooden bedsteads.

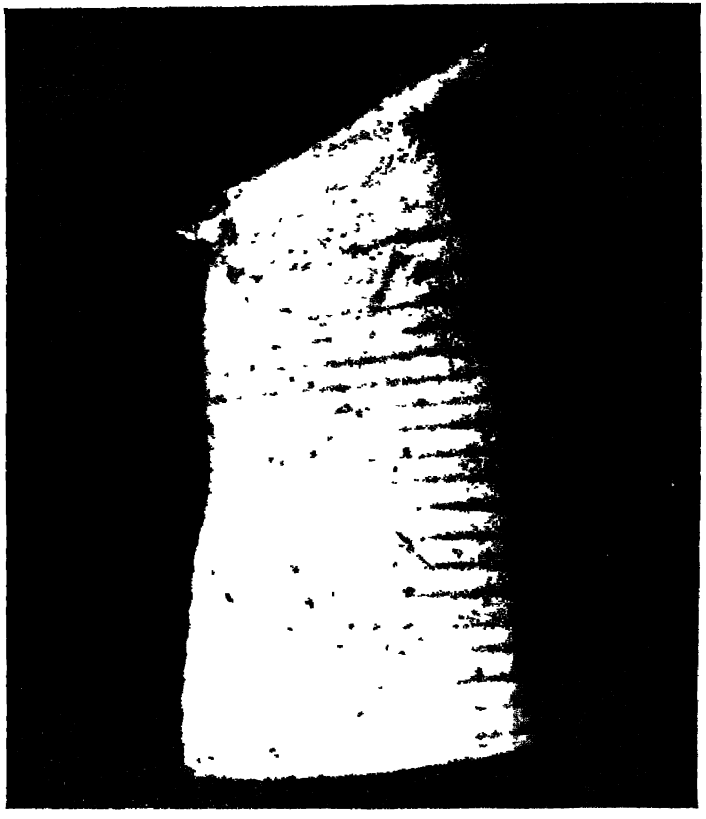
The "Jigger" Flea (*Sarcopsylla penetrans*) is a much smaller insect of a yellowish colour. It buries itself in the flesh of small animals and man. It particularly attacks the toes, and if not speedily removed causes a severe wound. Its body, partly by sucking moisture and partly by the development of the eggs, becomes greatly swollen, sometimes to the size of a small pea (fig. 60). It is a native of tropical America, but has been introduced into Africa

Fig. 54.



NEST OF A WASP, BUILT OF CLAY (502).
$\frac{1}{4}$ NAT. SIZE.

Fig. 56.



NEST OF CARD-MAKING WASP (*Chartergus chartarius*) (575).
$\frac{1}{6}$ NAT. SIZE.

(Photographed from specimens in the Museum.)

[*To face p.* 54.

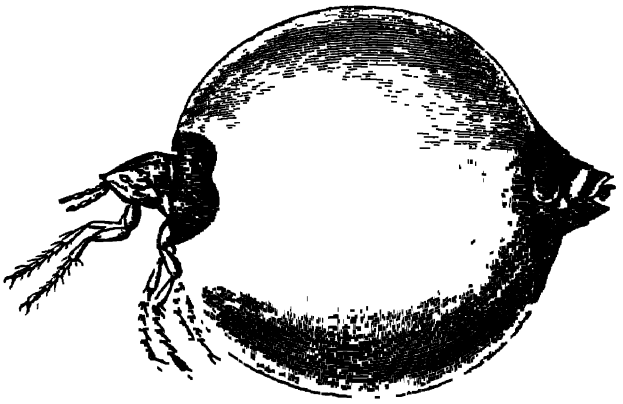
where it has spread rapidly. It has also been found in Madagascar and China. The natives in Africa who neglect to remove them frequently lose their toes in consequence.

Perhaps of all insects flies are man's greatest enemies, injuring his crops, fruit trees and vegetables, whilst others attack domestic animals, or are the means of conveying disease.

They are very diverse in their habits, even in the same family.

The *Cecidomyiidæ* are extremely small delicate flies. The larvæ of many species form galls, or swellings in the stems of plants. *Oligotrophus annulipes* (*Hormomyia piligera*) forms hairy tubercles on the upper surface of beech leaves (*see* model no. 87 on the east side of the gallery). *Contarinia tritici*, a Corn Midge, is injurious

Fig. 60.



Jigger flea (*Sarcopsylla penetrans*). Female with the abdomen distended. (Enlarged 10 times.)

to oats and barley. *Mayetiola* (*Cecidomyia*) *destructor*, the Hessian Fly, often causes serious damage to barley in some parts of the world. In England it appears to be kept in check by the numerous parasites to which it is subject.

Bibionidæ.—The larvæ of *Bibio* live on decaying vegetable matter in the earth; and when they come in contact with the living roots, they eat these. In this way, *Bibio hortulanus*, sometimes called a Fever Fly, does considerable damage to hops. The flies often appear in great numbers in the spring for a few days, and are seen crawling and tumbling about on the ground.

Culicidæ.—Gnats, for which the Spanish word, mosquito, is often used, have of late years come much into notice in consequence of

their biting habits, and the discovery of the part played by them in conveying disease, with which the species of *Anopheles* are specially connected.

Tipulidæ.—Daddy-long-legs, or Crane-flies.—The larvæ, which are called Leather-jackets, live on roots, and sometimes do considerable mischief to lawns and root crops. Some species live in decaying wood and other vegetable matter.

The *Asilidæ* and *Empidæ* are predaceous. They live on other insects which they capture, pierce with their rather short, strong proboscis and suck dry.

The *Syrphidæ*, or Hover-flies.—The larvæ of these flies are very diverse in their habits. Some of them are beneficial, as they feed on Aphids (Green-fly). They somewhat resemble leeches in form, and may often be found among the Aphids on roses or on fruit trees, &c.

The larvæ of *Eristalis* and its allies are totally different. They live in water saturated with decaying matter and filth. In order to obtain air the larva is provided with a long tube-like tail, which is capable of being extended for a considerable distance to reach the surface of the water, whence these larvæ have been called rat-tailed maggots. The larvæ of *Volucella* live in the nests of humble-bees and wasps. Those of *Merodon* feed in narcissus bulbs, and sometimes cause serious loss.

Tachinidæ.—The larvæ of the majority of *Tachinidæ* live in caterpillars. This they do without killing the caterpillar until they are fully grown, when they pierce through the skin of the host, and almost immediately assume the pupa form.

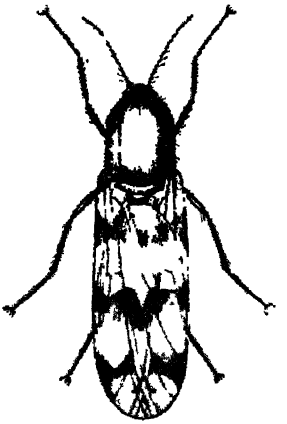
Œstridæ.—This family is of small extent but of great importance, since the larvæ live at the expense of vertebrate animals. *Gastrophilus* larvæ, called "bots," find their way into the stomachs of horses. The larvæ of *Hypoderma lineatum* and *H. bovis*, the Ox Warble flies, are found under the skin on the backs of oxen, whilst those of *Œstrus ovis*, the Sheep Bot, are developed in the nasal and frontal sinuses of sheep.

Another group of flies of considerable interest are the *Hippoboscidæ*, which live on mammals and birds. *Hippobosca equina*, known as the Forest Fly, is found on horses; *Lipoptena cervi* on deer. *Stenopteryx hirundinis* attaches itself to the house-martin. *Melophagus ovinus*, another member of this family, is known by the misleading name of Sheep-tick. It is a curious wingless insect, which lives among the wool of sheep, and when numerous has an injurious effect on the fleece.

There are perhaps no insects more remarkable than the species of *Nycteribiidæ*, which are spider-like wingless creatures with very long legs and large curiously-formed claws, and are parasitic on bats. Another very small, closely-allied insect which should be noticed is *Braula cæca*, which attaches itself to bees.

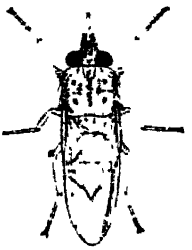
Considerable attention has been given of late to the biting and blood-sucking flies. Besides the gnats already referred to, some of the most troublesome are the biting midges: *Culicoides pulicaris* is one of the commonest (fig. 61). Species of *Simulium* are also serious pests in many localities. Specimens are exhibited in Table-case 50. Table-case 50.

Fig. 61.



Culicoides pulicaris.
(Greatly enlarged)

Fig. 62.



Glossina longipennis.
(Slightly enlarged)

Among the *Tabanidæ*, or Horse-flies, species of *Hæmatopota* and *Chrysops* are well-known biters, while *Stomoxys*, a genus of blood-sucking *Muscidæ*, includes several extremely troublesome and widely distributed species. Closely allied insects are the Tsetse-flies, *Glossina*, which are a serious menace to the development of Africa, since by means of their bite, the parasites causing sleeping sickness and nagana (Tsetse-fly disease among animals) are conveyed (fig. 62). There are several species.

A small series of flies will be found in Drawers 16–19 of a cabinet on the west side of the gallery.

Order COLEOPTERA.

The insects of this Order are called Beetles. They have a complete metamorphosis. The head is imbedded in the prothorax, which is very large. The front wings, called elytra, are not used in flight, but are hard and serve as covers to the hind wings, which are folded in a complex manner beneath them. When at rest they meet in a straight line down the back and do not cross one another.

They are commonly divided into twelve Sub-Orders, the principal characters for distinguishing which are explained by drawings and specimens arranged in a tabular form in Table-case 51. These Sub-Orders are again divided into many families, a few of which are illustrated in Table-cases 52, 53 and 54. A series of specimens will be found in drawers of a cabinet on the east side of the gallery.

Table-cases 51–54.

The larvæ are generally soft-bodied grubs living in concealment —Series of specimens illustrating the metamorphoses of *Melolontha* (129), *Propomacrus* (131), *Oryctes* (135), *Stenodontes* (137), *Spondylus* (139), and *Aspidomorpha* (143) are shown in Wall-case 8.

Wall-case 8.

Some problems connected with the geographical distribution of animals are suggested by beetles arranged upon maps placed on the West wall.

The commoner British Beetles are shown in a cabinet on the west side of the gallery, and a selected series of exotic representatives of the Order is contained in cabinets on the east side.

Some of the principal families of beetles are the following :—

The *Cicindelidæ* are exceedingly active predaceous beetles, of which the British species are known as Tiger-beetles. Their larvæ form perpendicular shafts in dry soil, and lie in wait to prey upon passing insects. Some of the tropical forms are arboreal and the larvæ of *Collyris* make their tunnels in the twigs of shrubs by boring a hole, through which they remove the pith.

The *Carabidæ*, Ground Beetles, are predaceous, most of them foraging by night, and lying hidden by day under stones, in crevices, etc. A remarkable exception to this rule is *Zabrus gibbus*, which eats the ears of corn. Several genera, e.g., *Brachinus* and *Pheropsophus*, have the power of extruding a drop of volatile and explosive fluid by which they disconcert their pursuers, whence their

popular name "Bombardier Beetles." In *Anthia*, *Graphipterus* and other genera the fluid is not explosive but acid, and causes pain and discoloration.

Paussidæ possess the same crepitating faculty. They are curious beetles which live in the nests of ants, and seem to secrete a sweet substance which is very agreeable to their hosts. All the species (about 300 are known) are easily recognised by the extraordinary forms assumed by their antennæ.

The *Gyrinidæ*, Whirligig Beetles, skim over the surface of ponds and rivers by means of their paddle-shaped middle and hind legs. The front pair form prehensile organs for seizing the insects upon which they feed. The larvæ live in the water.

The *Dytiscidæ* are adapted to a purely aquatic life, although able to fly well. They carry a supply of air between the elytra and the back, where the spiracles are situated. They also are predaceous.

The *Staphylinidæ* are very ready fliers, although their wings fold into a very small space and the wing-covers are very short. They include a multitude of small species, and the insects which so often fly into the eyes on summer days and cause them to smart, commonly belong to this group, especially species of *Oxytelus*.

The *Silphidæ* are chiefly carrion-feeders, and the species of *Necrophorus* have the curious habit of burying small carcases which they find upon the ground, by digging away the earth from beneath them. Their eggs are afterwards deposited upon them and the larvæ feed in security.

Coccinellidæ, or Ladybirds, are amongst the most valuable of all insects to agriculturists, most of them feeding both as larvæ and imagines upon the prolific *Aphidæ* and *Coccidæ*, which work havoc among so many crops. When other methods of extirpating these have failed in various colonies, the introduction of certain kinds of *Coccinellidæ* has, in some cases, proved very successful.

The Lamellicorns include many of the largest and most striking insects. Many species are very destructive to trees and crops. The Cockchafer, *Melolontha vulgaris* (see Wall-case 8, No. 129), is one of these. It eats the leaves of oaks and other trees, but the larvæ cause still more serious damage, by destroying the roots of cultivated crops. They generally pass three years in the ground before their development is complete.

Many *Scarabæidæ* are dung-feeders, like the long-familiar ball-rollers of the Mediterranean, Africa and the East. The ball when made is rolled with the hind legs until a sheltered spot is found

where it can be consumed in peace. For the young a hole is excavated underground and a quantity of the food-material carried down and worked into a ball, in which a single egg is laid. The ball is cased with clay, which retains the moisture, and afterwards serves as a cocoon. A loosely covered spot at the top admits sufficient air for respiration. Some of the cells, examples of which made by species of *Heliocopris* and *Catharsius* are exhibited, are of great size and weight. The two parents seem to co-operate in the labour of construction, and the nest is sometimes guarded by the mother during the development of the young.

The *Passalidæ* are found in tropical climates beneath bark or within decaying wood, upon which they feed. The two parents and larvæ of different ages are found together, the adult beetles gnawing the wood and preparing it for their young, which seem unable to exist without them. The larvæ are remarkable in being apparently four-legged, as the hind pair of legs are extremely small and serve as part of a sound-producing instrument. The claws of the hind leg scrape against a microscopically ridged plate at the base of the middle leg.

The *Lucanidæ*, or Stag-beetles, are well-known for the great enlargement of the head and jaws of the males. Most of them feed in rotten wood during the two or three years of larval life, but the large species, *Odontolabis siva*, cocoons of which are shown, feeds in the thatch of houses in the East, and the cocoons are made of gnawed pieces of this fastened together.

Ptinidæ and *Bostrichidæ* are exceedingly destructive to dry timber, woodwork and furniture, through which their larvæ tunnel until rapidly succeeding generations reduce it to powder. A piece of an oak rafter from the roof of Arundel Church, completely honeycombed by *Anobium tessellatum*, is exhibited.

A smaller species, *Anobium domesticum*, is the one generally responsible for the "worm-holes" so often seen in old furniture. These are the exits by which the beetles have left the wood when their development was completed and their tunnellings over. *Anobium paniceum* is also found in houses, where it attacks provisions, and even books, boots and leather articles allowed to rest long undisturbed. A small dried loaf and a book riddled by it may be seen in the table-case. These beetles are the mysterious Death-watches of old houses. By striking their jaws in regular time against resounding wood they produce a ticking noise which in a silent room is very distinct. It was no doubt more often heard in

days when wainscoting was common than in the present day, and it is not surprising that it was believed to be supernatural in the absence of any visible cause.

The *Lampyridæ* include the Glow-worms and Fire-flies. The males are always winged and the females often grub-like, but all forms, including the eggs, are luminous. They are predaceous insects, most, if not all, of them preying upon slugs and snails.

The *Elateridæ* are better known in the larval stage, as the Wire-worms so injurious to crops, than in the adult form, when they are often called Skipjacks, or Click beetles. The species of one Tropical American genus, *Pyrophorus*, are luminous and, like the *Lampyridæ*, are called Fire-flies. The light proceeds from spots upon the upper surface of the thorax. In the *Lampyridæ* it comes chiefly from the lower surface of the abdomen.

Most of the *Buprestidæ* are very brilliantly-coloured and the wing-covers of some of them are often used in Oriental embroideries. Most of their larvæ are long, flattened, legless grubs which feed in timber. The spiral burrow made in a bough of the Cork-oak in France by a species of *Coræbus* is exhibited.

The *Meloidæ* are parasites, feeding during the larval period upon the eggs, young, or stored food of other insects. *Meloe proscarabæus* is a common British species. It undergoes several extraordinary changes of form before reaching the pupal stage. The mature insects feed upon foliage, and are protected from birds and insect-eating animals by a caustic secretion which they can exude and which is extracted and used medically under the name of cantharidine.

The *Curculionidæ*, or Weevils, are an enormous family of vegetable-feeders, many of which cause serious injury to cultivators. One of the largest of them is the Palm-weevil (*Rhynchophorus*) which destroys the interior of the Cocoanut Palm, working upwards from the roots and ultimately reducing the tree to a shell.

A very injurious species found in this country is *Pissodes notatus*. A small piece of young Austrian pine infested by this insect is exhibited. An entire plantation of young trees of this species at Dorchester was destroyed. The habits of several other British Weevils are illustrated by models on the East side of the Gallery. *Ceuthorrhynchus sulcicollis* (55) produces excrescences upon turnips or cabbage stems within which its larvæ feed. The Apple-blossom Weevil, *Anthonomus pomorum* (53), kills the flower buds of the apple tree, one egg being laid by the mother in each bud. The

female of *Attelabus curculionoides* (57) cuts oak leaves across the middle, leaving the mid-rib intact. The terminal half then falls back and is neatly rolled into a closed cylinder within which an egg is placed. The larva lives and feeds within this shelter, eventually falling to the ground to pupate. *Rhynchites betulæ* (59) treats birch leaves in a similar way, but the cell is sugar-loaf shaped instead of cylindrical.

Scolytidæ are small beetles which bore into trees, the larvæ of most of them feeding upon the soft layer immediately beneath the bark. The borings of several species of *Scolytus* are shown. The female drives a tunnel just beneath the bark and along it places her eggs at regular intervals. Each little grub upon hatching proceeds immediately to eat its way into the same layer, the tunnels increasing in diameter with the growth of the inmates, but always keeping separate, so that they become more and more oblique towards the end of the colony. Curious and beautiful patterns are traced in this way upon the surface of the wood. Certain other Scolytidæ live socially within cavities in tree trunks, feeding upon fungi which grow within the cavities and are even said to be cultivated by the beetles.

The Longicorns are wood feeders, attacking forest trees in every part of the world. They sometimes emerge from wood which has been in use for some time, and in which the larvæ have been concealed. Parts of the batten of a claret cask pulverised by *Hylotrupes bajulus* are shown, together with specimens of the beetle. Two other species shown sever small branches by gnawing a circular groove around them. This is done by the female when laying her eggs. The cut branch snaps off at the incision and the larva feeds within it as it lies upon the ground. In a model against the East Wall are shown branches of poplar attacked by *Saperda populnea*, the female of which lacerates the bark with her mandibles and deposits an egg at the injured spot. The larva enters the wood and feeds within the swelling produced.

The *Chrysomelidæ* are chiefly leaf feeders, and some of them, like the Colorado Potato Beetle (*Doryphora 10-lineata*), are very serious pests. That species, although it has been accidentally imported into this country and the Continent, has hitherto not succeeded in establishing itself permanently. The Mustard Beetle (*Phædon cochleariæ*), a common British species which destroys the leaves of mustard, is shown in a model. Most of the members of this family possess offensive juices which protect them from the attack of insectivorous

animals, and *Diamphidia nigro-ornata*, of which larva, cocoons and imago are shown, is so poisonous that the natives of Ngamiland use it for poisoning their arrows.

The *Cassididæ* or Tortoise-beetles. Several species are shown, together with the remarkable egg-cases of several South African forms. Each egg is contained in a separate cell in a beautiful honeycomb-like structure, gradually built up by the female from a glutinous secretion. The larvæ have a curious pair of long tails, which are carried over the back. The skins cast successively, four in number, are held, together with the excreta, by these tails, and form a kind of mask throughout the larval stage.

Order RHYNCHOTA.

This Order includes the Bugs, Cicadas, Froth-flies, Aphids, and Scale Insects.

They undergo incomplete metamorphosis. The head is imbedded in the prothorax which is very large. The mouth is modified so as to form a long proboscis, formed for piercing and for sucking juices; it lies beneath the body when at rest, directed backwards.

They are divided into two Sub-Orders, the HEMIPTERA and HOMOPTERA.

A series of specimens, with explanatory drawings and labels, is in course of preparation, and will be exhibited shortly in Table-cases 55 and 56. Table-case 55.

The HEMIPTERA have the base of the front wings leathery, the apical part membranous, crossed over one another when at rest. This Sub-Order includes all the Plant Bugs, Tree Bugs, House Bug, etc.

A small series of specimens will be found in Drawers 9–12 in a cabinet on the west side of the gallery. They live on the juices of plants. A minority, however, attack and suck moisture from caterpillars and other insects, especially species of the family *Reduviidæ*, and some will bite human beings, the bite in some cases being as painful as the sting of a wasp. *Sirthenea stria* is one of these in Trinidad. *Conorhinus infestans* is mentioned as being very troublesome, and *Conorhinus sanguisuga* causes great pain and inflammation. These are South American.

The Common House Bug (*Cimex lectularius*) feeds on moisture drawn from pine wood, hence it is often found breeding behind pictures left undisturbed and behind wainscots. This species is not met with in England away from houses, but three species, *Cimex columbaria*, *C. hirundinis* and *C. pipistrelli*, are found in the nests of pigeons, swallows and bats respectively.

Aspongopus nepalensis, a large species, which hides itself under stones in dry river beds in North India, is sought for and eaten by the natives.

The HOMOPTERA have wings of the same texture throughout, held roof-like when at rest. This Sub-Order includes the Cicadas, Froth-flies, Aphids, etc. A small series of specimens will be found in Drawers 13–15 in a cabinet on the West side of the gallery.

The Cicadas have brought themselves under notice from the earliest times by the sounds that they produce. This sound is produced by a complex structure at the base of the abdomen. In their early stages they live under ground on roots. The pupæ are remarkable looking creatures.

The *Fulgoridæ* include the Lantern Flies, so called on account of the curiously developed heads of some of them. Many members of the family secrete a white waxy substance from their abdomens. One of the most remarkable is *Phenax*. The young of species of *Flata*, covered with this white waxy substance, are sometimes found in masses. A beautiful example is exhibited.

The wax secreted by *Fulgoridæ* is used for making candles in China.

The *Membracidæ* are noteworthy on account of the very curious shapes taken by the pronotum.

To the *Cercopidæ* belong our British Froth-flies and their allies. One of the commonest species, *Philaenus spumarius*, is well known as living on garden plants. In their early state they surround themselves with white froth. The full-grown insects, called Frog-hoppers, are very injurious. They constantly prick the young leaves in order to suck the juice. Afterwards, as the leaves grow, these pricks become holes and the leaves often get much withered.

The *Aphidæ* are known as Plant-lice or Green-fly.

The *Coccidæ* are called Scale Insects from the scale-like appearance of the females of many of the species. The males are delicate insects with one pair of wings only. Examples of the males and females of the largest known species, *Lophococcus maximus*, from Rhodesia, are exhibited.

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